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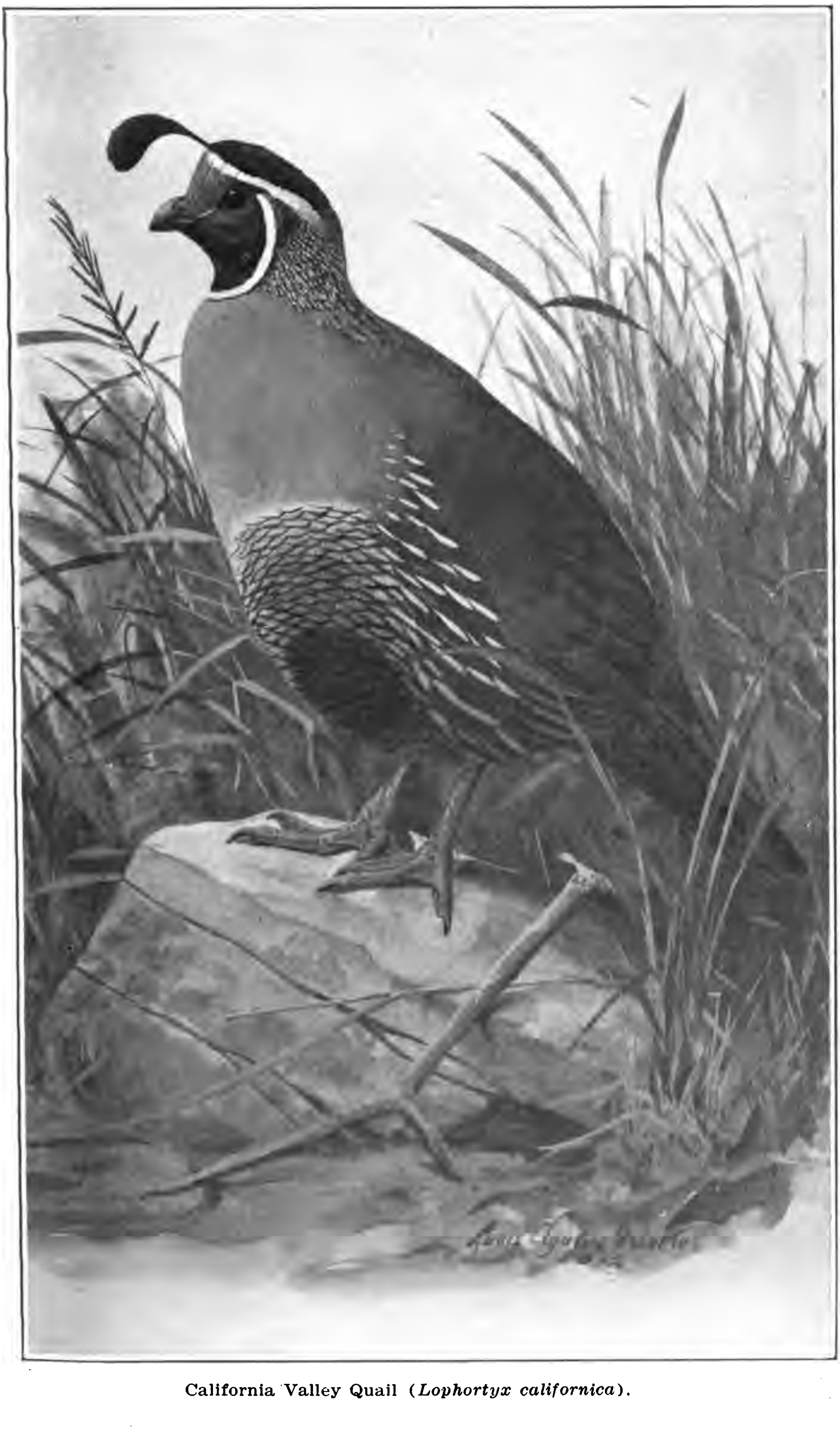

California Valley Quail (*Lophortyx californica*).

INVESTIGATION OF THE LARGE GAME SITUATION IN CALIFORNIA WITH SPECIAL REFERENCE TO DEER.

By FRANK C. CLARKE,

Fellow in Applied Zoology on the Fish and Game Commission Foundation, in the University of California.

PURPOSE AND HISTORY OF THE INVESTIGATION.

The large game animals of California constitute one of the most important groups of game in this State. That some of these animals are rapidly approaching extinction is a fact which needs no proof. The older sportsmen, and hunters in general, testify to the great decrease in the number of deer, elk, mountain sheep, and antelope that has taken place in California during the past three or four decades. In consequence of the importance of this game, and in view of the fact of the materially lessened numbers, the Fish and Game Commission has undertaken a special study of the subject, with the hope of establishing a more efficient system of conservation, one that not only will prevent the extermination of these animals, but will result in an increase of the present numbers, so that the large game animals may become a permanent source of wealth for the people of the State.

Until recent years, the work of conserving the large game supply of the State was a matter regulated by a more or less arbitrary set of game laws, enforced by a corps of field deputies of the Fish and Game Commission. This system of conservation, though partially efficient, lacks the scientific considerations which are the essential basis of all successful conservation work.

Our large game has decreased to the point where radical measures must be taken in order to preserve it as a factor of economic importance. The investigation that has recently been instituted aims to solve the question of large game conservation, by putting the system on a sound scientific and thoroughly practical basis.

This movement was initiated by Dr. T. S. Palmer of the United States Biological Survey, and the proposition, as taken up, was presented to the State Board of Fish and Game Commissioners by Dr. C. A. Kofoid, Professor of Zoology at the University of California, who pointed out the value of such an investigation, both from the scientific and from the economic points of view.

Owing to the recent inception of the work, it is impossible to give a final report on any feature at this time; however, considerable study preceded the present official investigation, which dates from June 25, 1912. During the summer and fall of 1911, an investigation was made of an epidemic among the deer of Trinity County; and for more than a year careful study was made of the diseases and parasites of the deer.

This latter work was carried on at the University of California, in the Departments of Parasitology and Zoology.

The investigation of the life history of our large game animals and of all that pertains thereto will be continued by the Commission, with the coöperation of the Department of Zoology of the University of California. It is both scientific and economic in purpose. Field work is being supplemented by study in a thoroughly equipped laboratory at the University. In connection with the work, a collection is being made of literature on the natural history of large game in the West, especially the deer; this also includes a special collection of enactments relating to the various species of this game by the various states and countries.

The work is being conducted along two lines: first, to gather exact data as to the past and present conditions of the deer, elk, mountain sheep, and antelope (especially the former); to determine the varieties of each and their geographical distribution, their seasonal migrations, their life histories, and habits and, in fact, everything concerning the life of these animals.

The second consideration, and the ultimate aim of the undertaking, is to work out an adequate system of game conservation for the State; this will include the maintenance and increase of our large game, especially deer; the establishment of game farms and game refuges, and the stocking of these farms and refuges, also forest preserves; and the importation of new species into the State—species that not only will bear the climate, but that will breed well and be productive.

THE DEER OF CALIFORNIA.

PARASITES AND DISEASES OF THE DEER.

Before taking up the consideration of the different species of deer, brief mention will be made of the work done in relation to the diseases and parasites of these animals, and especially of the black-tailed deer (*Odocoileus columbianus columbianus*).

As it was the epidemic among the deer of Trinity County, in August, 1911, that led the Zoological Department of the University of California to take up the study of the parasites and diseases of the deer, mention should be made of this occurrence. During the summer of 1911, an epidemic appeared among the deer in southern Trinity County; it spread over the entire southern half of the county, and from there into southern Humboldt, northern Mendocino, northern Lake, and western Tehama counties. There is as yet no proof as to the exact cause of the disease, but all evidence that has been collected indicates that it was a bladder worm infestation—the parasites infesting the liver, intestines, lungs, and other vital organs. Reports came from the infested territory that deer were dying by hundreds and even thousands. Whether all the deaths reported during the fall and winter were caused by the disease as first found in Trinity County cannot be said. Many of the reports were doubtlessly greatly exaggerated; but granting this, many deer died.

Deputy Fish and Game Commissioner G. O. Laws, of Trinity County, estimated that probably 5,000 deer died of the disease in that county alone. This estimate may, at first, appear to be exaggerated; but, as shown below, it is supported by the following facts:

Trinity County has an area of 3,276 square miles, most of which is mountainous country, and deer are found in nearly all of this territory. When in Trinity County, near Douglas City, the writer, with Mr. Laws' assistance, discovered thirty deer carcasses within an area of three square miles; and not over ten or fifteen per cent of this small tract of land was gone over, as it was very rough, and covered with timber. If deer died all over the country as they did within this particular area, it would mean a loss of 32,760 animals; but, estimating the death rate at only one fifth of this number, leaves a total of 6,552; or, if only one animal died per square mile (a very conservative estimate), that alone would total 3,276.

Whatever the cause of death, it was a serious injury to the game in the regions affected, and justified a thorough investigation on the part of the State. It will take years for the deer to regain their former numbers, so that in order to afford them every advantage, wherever the disease was prevalent, the season should be closed for a number of years.

Since the investigation of the epidemic among the deer of northern California, in the summer of 1911, a careful study has been made of the parasites of deer, and their position as possible transmitters of disease. Following a period of the epidemic, a report of the work done was filed by the writer in the general library of the University of California.

It was found that the black-tailed deer (*O. columbianus columbianus*) north of San Francisco Bay harbors internally and externally at least fifteen different species of parasites. Most of these are, perhaps, harmless; but the relation of a parasite to its host, its position (whether in the blood or otherwise), the number of these parasites present, their ability to transmit disease germs, or to produce toxins in the blood of the host, are all factors to be considered.

Following is a partial list of the parasites of the black-tailed deer:

PARASITES INFESTING THE BLACK-TAILED DEER (*Odocoileus columbianus*).

Number.	Parasite.	Position on host.
1	Louse flies (*Lipoptena depressa*)	External.
2	Louse flies (*Lipoptena* sp.)	External.
3	Common flea (*Pulex irritans* var. n.)	External.
4	Bot flies (*Cephenomyia* sp.)	In nasal cavities and pharynx.
5	Biting lice (*Trichodectes parallelus*)	External.
6	Sucking lice (*Hamatopinus crassicornis*)	External.
7	Deer tick (*Ixodes ridinus,* var. *californicus*)	External.
8	Common tick (*Dermacentor occidentalis*)	External.
9	Round worms (*Setaria labiata papillosa*)	Abdominal cavity.
10	Thread worms (*Nematodirus filicollis*)	Intestines.
11	Thread worms (*Chabertia ovina*)	Intestines.
12	Sheep lung worms (*Dictyocaulus filaria*)	Bronchia and lungs.
13	Tape worms (*Thysanasoma actinioides*)	Intestines.
14	Tape worms (*Noniezie* sp.)	Intestines.
15	Bladder worms	Abdominal cavity.

Further work on the bacterial and protozoan parasites was carried out, but no final report has yet been made on it.

Deer with small infestations of these parasites may not materially suffer; but where heavy infestations occur, the animal becomes seriously diseased and death often results. It is not to be supposed that even a complete knowledge of all the parasites and diseases of deer would enable us to remedy every or any complaint; but it is certainly some satisfaction to know what a particular disease is and how it is communicated. However, it is not an impossibility in all cases to find at least a partial remedy. In the case of bladder worms transmitted by carnivorous animals, the remedy lies in the destruction of the latter.

In the case of anthrax it appears that this disease, if ever destructive to deer, may be largely controlled by control among domesticated animals. This is assumed from the fact that deer do not appear to have carried the disease to any extent, if at all, from infected cattle, on ranges where the latter were present and ran in close proximity to the deer.

For a few years following the advent of fire, the deer in the burned area are much freer from parasites than those in brushy country, where fires have not cleared the vermin out, and left the country strewn with ashes, a product which is a parasiticide to a greater or less extent. Furthermore, burning over a brushy country causes an increase of good pasturage for the next few years. Good pasturage insures deer in a fat and healthy condition; and any animal in good condition is better able to resist the attacks of parasites than one that is poor and thin.

SPECIES AND VARIETIES OF DEER IN CALIFORNIA.

(Genus *Odocoileus.*)

There are two distinct species of deer in California, and at least five subspecies. The classification here used is that employed by Dr. C. Hart Merriam of the Biological Division, United States Department of Agriculture, and by other eminent authorities on North American animals.

The black-tailed deer (*Odocoileus columbianus*) is for the most part a coast form that is found from Los Angeles County to Alaska. This deer is well restricted to the Coast Range, but has, however, been reported at various places in the Sierra, though the great majority of the deer of the Sierra, south of Madera County (and probably north to Oregon), are the mule-tailed deer (*Odocoileus hemionus*).

There is a gradual change from the southern form as the black-tailed deer approaches its northern limit; those south of San Francisco Bay are classed as subspecies (*O. columbianus scaphiotus*); from the bay north to British America is found the true type of the Columbian black-tailed deer (*O. columbianus columbianus*); and the northern variety, that of the Alaskan region, is classed as *O. columbianus sitkensis,* or sometimes simply *O. sitkensis.*

While there is no great difference in the animals from immediately adjacent localities, marked differences are apparent in those widely separated; for instance, between those of Monterey and Del Norte counties, or those of Del Norte County and Alaska.

Thus, of the three subspecies of black-tailed deer, two occur in our State. The other species of deer in California is the mule-tailed deer (*O. hemionus*), with its three subspecies; unless, perhaps, the form known as "burro deer" (*O. hemionus eremicus*) is extinct. This latter variety formerly inhabited the lower Colorado River and adjacent regions of the desert. It is the largest of the California deer, and due to the fact that it inhabited the low, open county, largely along water courses, was readily killed off. According to reports, if any of these deer are left in California they are out in the Colorado River country, in the vicinity of the Chocolate Mountains.

The true mule-tailed deer (*O. hemionus hemionus*) ranges in the southern Sierra, north to Madera County, and very probably the same form is found north of this region to Oregon and Nevada. Dr. T. S. Van Dyke mentions in "The Deer Family" a larger "mule-tailed" deer from northeastern California. He believes it to be a separate type; but this opinion does not seem as yet to have been confirmed by mammalogists, though the matter has not been thoroughly investigated.

Mule-tailed deer are reported from Trinity County northward to the Oregon line; but even if these reports be true, the numbers in which the deer exist, and the occasion of their presence there is not known. But mule-tailed deer west of Mt. Shasta are probably only stray animals from the northern Sierra. Just how far these deer range west in the Tehachapi and the Siskiyou mountains is as yet unknown; but the Mt. Shasta country and the Tehachapi Pass seem to be approximately the limits to the westward.

The coast form of this species (*O. hemionus californicus*) has been given the name "California mule deer;" the name, however, misleading, as there are two other mule-tailed deer in California. This variety is the smallest of the mule-tailed deer, being about the size of the southern black-tailed deer. Its range is approximately from San Luis Obispo County southward into Lower California, and from the coast eastward to the Tehachapi and the desert region.

Many old hunters speak of the "Pacific buck" or the "Pacific forkedhorn," also of the "chemisal deer" or "brush buck." Dr. T. S. Van Dyke, in "The Deer Family," refers to a small buck of the Mexican border that corresponds somewhat to the "chemisal" deer described by hunters. They are reported to be very scarce. Thus far we have been unable to secure any specimens of these forms, nor have we been able to ascertain whether or not reports concerning them are authentic. The "Pacific buck" is reported from all over California, within the ranges of the two subspecies of black-tailed deer and two important species of the mule-tailed deer. There seems to be no scientific basis for recognizing the "Pacific buck" as a separate variety, on account of the uncertain character upon which the classification is based, namely, the antlers.

LIFE HISTORY AND HABITS OF DEER.

In general, the life histories and habits of the several species of deer do not differ greatly; yet even among those of the same variety there is considerable variation with regard to migration, rutting, etc.; and these differences are of the utmost importance in the consideration of legislative measures regarding the open and closed seasons on deer.

In general, we know that deer are more or less gregarious in nature; that they are polygamous; that they rut in the fall; that they breed first at the age of about sixteen months; that the period of gestation is about six months; that the females normally give birth to two fawns; and that deer, especially the bucks, have a tendency to migrate from lower to higher altitudes early in the summer and retreat during the fall. But this information is entirely too general and fails to be sufficiently specific in nearly every case. For example, the deer of Napa and Marin counties are of the same variety as those of Trinity County; yet, due to climatic and topographical differences, the deer of the southern region come into good flesh, migrate, and rut fully a month earlier than those of the northern section. By the first week of August, the bucks in Marin County are fat and shedding the velvet; they migrate but little, on account of the restricted area in which they are found; and the rutting season is on from the last of September to the close of October. In Trinity County there is a marked migration to higher altitudes in early summer and a return to lower altitudes in the fall. Rutting begins the last of October and runs through November.

Another instance of the differences in the seasonal life history of members of the same species is noted in the deer of the southern Sierra, where those in the foothills rut fully a month earlier than those of the higher altitudes. So we find many instances of variations not important in themselves, but when considered in the aggregate very important from the standpoint of game legislation.

DISTRICTS AND THE OPEN SEASONS.

In considering an open season on game, and especially on deer, the essential thing is to establish the opening and closing dates of the season, and the length of the season with reference to the best interests of the animal. The convenience of the hunter should be made of secondary importance to the welfare of the game. When this principle is not strictly adhered to, any system will fall short of the desired result. Deer and any other game should be killed only when it is in the best condition, and when the killing of it will least affect the maintenance of a permanent stock.

The present districting of the State, and in most cases the open seasons in these districts, is wrong. In the first place, districts have been established, based on artificial and natural boundaries, and irrespective of life zones; county lines or mountain ranges have been used as dividing lines, resulting, in many cases, in the separation of similar or identical groups of animals, existing under similar conditions.

The evils of the present system are made evident in the following instance: The boundary line between Humboldt and Mendocino counties forms, in part, the line of demarcation between the first and second game districts. In Mendocino County the deer season opens forty-five days earlier and closes sixty days earlier than it does in Humboldt County. There is, in consequence, hunting in both counties, for twenty-five miles on either side of the boundary line, during four months of the year—from the first of July to the first of November. Where these artificial boundary lines are recognized, it is impossible to prevent violations of the law,—hunters will invade the closed district and bring game back across the line. The above instance is only one of many that have been a source of constant trouble under the present system. However, it is impossible to entirely overcome this difficulty.

Since there is more need of a district system for deer than for any other game, an attempt will be made to outline a districting scheme with reference to them. In this day deer are animals of the mountains, and not of the large valleys; consequently, where possible, these latter natural feautres should be observed as boundaries when creating game districts.

Thus, such a dividing line as is made by the two large rivers of our great valleys would come as near meeting the need as would be necessary to separate the coastal (early) country from the Sierran (late) country. This line if extended north from the Sacramento River to the Oregon boundary and south through the San Joaquin Valley to the Tehachapi Pass and on to the deserts, would divide the interior mountain ranges inhabited by deer from the coast ranges; it would be a line over which there would be but little transgression, except, perhaps, in the very north and in the Tehachapi; and it would approximately separate the true type of mule-tailed deer from the black-tailed deer in the northern half of the State, and the true mule-tailed deer from the southern black-tailed deer and the coast mule-tailed deer in the southern half. The Sierran country requires a season decidedly later than that of the Coast Range; and the coastal counties north of San Francisco Bay, a later season than the country south of the bay. In consequence of this latter fact, it would be necessary to subdivide the coastal region in the neighborhood of San Francisco Bay. Futhermore, the extreme southern part of the State, south of the Santa Maria River and the Tehachapi and Sierra Nevada mountains, should form a district by itself. It might also be advisable to put Del Norte, Humboldt, and Mendocino counties in a district by themselves, on account of the seasons being considerably later in these counties than in Marin, Napa, etc., but earlier than in Trinity, Siskiyou, Shasta, etc.

Then, from the standpoint of the geographical distribution of the different species of deer and climatic and topographical considerations, there are but four great divisions in the State, as follows:

(1) The coast country west of the Sacramento and Shasta rivers, and south from the Oregon line to the confluence of the Sacramento River with San Francisco Bay;

(2) The country west of the San Joaquin Valley and the great deserts and south of San Francisco Bay to the Santa Maria River;

(3) The Sierra Nevada Range of mountains in California, including all of the State east of the two great valleys, and from Oregon to the great deserts;

(4) The entire southern part of the State below Santa Maria River and the southern boundaries of Kern and Inyo counties. This latter line would approximately separate the coast mule-tailed deer and the desert deer from the southern black-tailed deer and the mule-tailed deer of the Sierra.

Such an arrangement would be a logical districting of the State, based on the three essential factors—*climate, topography and fauna.* However, for administrative purposes, it would, perhaps, be necessary to modify this outline somewhat, and even to split certain of the above indicated divisions. Therefore, to make this system operative from the standpoint of administration it is suggested that the State be divided as follows:

District No. 1.—To include Siskiyou, Modoc, Trinity, Shasta, Lassen, Tehama, Plumas, Butte, Sierra, Sutter, Yuba, Nevada, Placer, Sacramento, El Dorado, and Amador counties.

District No. 2.—To include Del Norte, Humboldt, Mendocino, Lake, Glenn, Colusa, Yolo, Napa, Sonoma, Marin, and Solano counties.

District No. 3.—To include Calaveras, Alpine, Tuolumne, Mono, Mariposa, Madera, Fresno, Tulare, Inyo and Kern counties; and such part of San Joaquin, Stanislaus and Merced counties as lie east of the west bank of San Joaquin River; and such part of Fresno County as lies east of the west bank of San Joaquin River and Kings River Slough; and such part of Kings County as lies east of the west bank of Kings River Slough; and east of the west bank of Tulare Lake and Bull Slough; and such part of Kern County as lies east of the west bank of Bull Slough and the west bank of Buena Vista Lake; and on the northerly side of a line drawn from the southernmost point of Buena Vista Lake eastward to boundary of El Cajon Rancho and thence northerly to where the boundary of El Cajon Rancho crosses the Southern Pacific Railroad; thence southerly to the intersection of the Southern Pacific Railroad and the Kern County line.

District No. 4.—To include Contra Costa, San Francisco, Alameda, San Mateo, Santa Clara, Santa Cruz, Monterey, San Benito, San Luis Obispo, and all parts of San Joaquin, Stanislaus, Merced, Fresno, Kings, and Kern counties not included in District No. 3.

District No. 5.—To include Santa Barbara, Ventura, Los Angeles, San Bernardino, Orange, Riverside, San Diego, and Imperial counties.

The present system is neither logical nor scientific. There is no place in the State where deer are fit to kill in July. In the fifth district, at the end of July, scarcely any antlers are out of the velvet, and the deer are far from being in their prime. The same thing is true in the second district. Conditions in the fourth district are decidedly worse than in any of the others, as might be expected from the topography and climate of the region. Spring in the Sierra is from one to two and a half months later than it is in the coast country, and we cannot expect to find the condition of the deer or any other game in advance of the vegetation which supports the animal. The heavy snows of winter drive the deer from the high regions to the foothills, but as the snow recedes with the breaking of winter, the deer return to the mountains, following the snow-line, often weeks in advance of vegetation. As a result, by the first of July the deer in the Sierra are just beginning to "flesh up"; the does are rearing their young; and the bucks are growing their antlers, a peculiar phenomenon that is a great drain upon the vitality of the animal, depriving the flesh of much nutritive value.

The present investigation has shown that even at the end of July most of the bucks in the southern Sierra had but very little fat on them, and none were out of the velvet, most of the antlers being very immature. Examination was made of several pairs of very large antlers from Kern County, taken about August 10th; they were not only in the velvet, but were so soft that they could not be preserved for mounting; these were not exceptional cases.

Conditions in the other districts, while not so bad, are nevertheless open to considerable criticism.

In fixing the opening of the deer season in the several districts, the following facts should be thoroughly recognized and taken into account:

First—Bucks should not be killed until they are fat. The meat of a lean animal is more or less stringy and lacking in flavor; besides which poor animals do not yield nearly so much meat as fat animals.

Second—They should not be hunted while the antlers are in the velvet; for during this period they remain in the open, giving their antlers the benefit of the sun; they will scarcely take to the brush even when closely pursued, as the immature antlers are as sensitive as the fingers of a human, and much more easily injured.

Third—Immature antlers are practically worthless, and the preservation of them is more or less objectionable on account of the obnoxious odor which they usually give off after they are mounted.

Fourth—Most important of all is the condition of the fawns. Prior to the time when the bucks reach their prime, the fawns are small and practically helpless. The presence of a great army of hunters stalking through the woods at this time often results in the destruction of many small deer. Careless or excited hunters not infrequently shoot a doe. If it is early in the season, before August or September, it is almost certain that her fawns will die; also, young fawns are separated from their mothers as a result of being run by dogs taken into the field by hunters. Later in the season the fawns would be old enough to care for themselves; and, furthermore, they would be better able to keep beyond the reach of dogs.

The closing of the open season must be determined by the rutting season. Deer should not be killed after the rut is on, as the bucks soon grow poor, and the flesh becomes tough and musky.

The foregoing principles have not been adequately considered in establishing game districts in this State, and we would advise a complete change.

Regarding the open season on deer, it is suggested that in no place in the State should the season open before August 1st, and preferably not until August 15th. While there is no other state in the Union that has conditions so varied as those in California, there are some states where conditions are similar to those found in certain parts of California. In only one other state (Oregon) does the deer season open even as early as August 1st. The Southern States, Texas, Alabama, and Florida now do not open their season on deer until November 1st. Thirteen other states also open their season during November. Nine other states open the season in September, and nine in October. The average length of the open season for each state is fifty-five days.

In California, where in most regions deer rut shortly after coming into prime condition, it is necessary to have rather a short open season.

Under the proposed districting scheme, as described on page 13, the seasons should be open in the several districts as follows:

District No. 1.—September 1st to November 1st.
District No. 2.—August 1st to October 1st.
District No. 3.—September 1st to November 1st.
District No. 4.—August 1st to September 20th.
District No. 5.—August 15th to September 15th.

While the above outlined plan may not be adapted to all conditions in all localities, it is obviously impossible to arrange any system of districting or open and closed seasons to fit every section of the country perfectly.

The idea in fixing the seasons as above indicated is to have them open on the earliest possible date which finds the deer in prime condition, and close so as not to conflict with the rutting season. Setting August 15th as the opening date for the season along the coast would give every one wishing to hunt an equal chance to shoot in the Coast Range. Hunters who make a business of visiting the different districts as the seasons open, and killing a limit in each, would thus have their opportunities for evading the law lessened. The season in the south should close early, as the deer are scarce there and the rutting season is early; in the north, the season can remain open longer, the rutting season being much later than in the south; while in the Sierra, the season should come late in the fall.

There are several reasons why a "blanket" law in California would be preferable to the present districting system. The districts and district boundaries would be done away with and enforcement of the laws would be simpler. If a "blanket" law should be adopted, August 15th to October 1st would seem to be the time best adapted to the whole State. The adoption of such a law is not, however, advocated, as the differences in the varieties of deer and the climatic conditions under which they live are too great in the various parts of the State.

There are a great many game enthusiasts in California who advocate a closed season on deer for a period varying from one to ten years. For many reasons a prolonged closed season would be most advantageous; there are, however, several arguments against it. It is doubtless true that a few mountain people would be eating venison while no one else would be allowed to get any, but they would do this under any system that could be devised; it is obviously impossible to have deputies patroling in every part of the State at all times. And, too, there might be a considerable increase in the number of predatory animals, on account of there being fewer hunters in the field; unless some special system were adopted for their destruction. Furthermore, there would be a considerable loss to the people of the State of the money that is put into circulation by the army of hunters that annually visits the deer country during the open season.

Judging from the testimony of deputies of the Commission and of many sportsmen in the State, there is no need at present of a closed season throughout the entire State, provided that the laws relating to deer be based upon the following considerations: First, the protection of male deer with unbranched antlers shorter than the ears; second, the adoption of laws whereby a "tag" system is created; third, the enactment of a law giving deputies of the Commission authority to search all hunters and all places except residences; fourth, the requirement that a man with venison in his possession, in camp or in the field, be required to produce the head or hide or both, or give proper explanation as to the source whence the venison was obtained; fifth, the reduction of the bag limit to one buck per season.

Supervisors of the various counties throughout the State should be empowered to close the season on deer or any other game when conditions warrant it.

DAMAGE DONE BY DEER.

The Commission receives many reports of the damage done by deer to crops and orchards. Without doubt considerable harm is done at times to young orchards and to some annual crops, but the amount is usually exaggerated about tenfold. A typical case is cited. The owner of 2,000 fruit trees claimed that deer damaged his crops to the extent of $100 per year. On investigation it was found that in 1912 the damage consisted of the removal of the leaves of bearing trees from around the basal portions. There was no barking of the trees at all, and little or no sun-scalding as a result of the defoliation. The damage for the year did not exceed ten or fifteen dollars; if it was that much. However, when orchards are young, the damage is in proportion to the number of trees that are killed or so badly topped as to result in malformation.

To fence deer out is out of the question for the average farmer. Where real destruction is going on, reimbursement of the injured parties should be made possible through proper legislation.

RELATION OF CARNIVOROUS ANIMALS TO DEER AND OTHER GAME.

The mountain lion is the greatest enemy of the deer, man not excepted. Nearly every old hunter or mountaineer will claim that an adult mountain lion will kill at least fifty deer per year. There are records of a lion's killing three or more deer in one night. It is the lion's nature when hungry to kill a fresh supply of meat; that which remains after his meal is devoured by coyotes and bobcats and other small carnivora.

Figuring on the above estimate of fifty deer a year killed by each mountain lion, consider as to whether or not the Fish and Game Commission is justified in paying a twenty dollar bounty on these animals. Some hunters claim that lions kill large deer in preference to small ones. To what extent this is true, cannot be said, but it is known that many a big buck falls in the woods—a victim of the mountain lion.

Of the fifty deer killed, forty pounds is a moderate estimate of the average dressed weight of each animal. As meat, the flesh is worth at least 12½ cents per pound, giving a minimum market value of at least five dollars per head; while the average buck that is killed by hunters is worth at least ten dollars, though the value that each hunter puts on his deer is from two to ten times this amount. Out of fifty deer killed, perhaps half are does. We can figure that the breeding does of this lot would raise normally each year, at least thirty fawns, which we would value at five dollars each, as the cost of production is practically negligible. In other words, we lose fifty deer annually from each mountain lion and our supply of deer is cut short at least thirty more, which is three fourths the increase from these fifty does rearing normally two fawns yearly, and there being about nine months of the year that the killing of a doe means the loss of a chance for at least one fawn, and most probably two, for that year.

From the above figures it easily may be seen that a single lion is responsible for the death of at least eighty deer during the year, from which we deduce the following:

Eighty deer at $5.00	$400 00
Cost to State of destroying a mountain lion	20 00
Balance in favor of the game	$380 00

Thus, with the destruction of each mountain lion, $380.00 in deer meat alone is saved to the people of the State each year, to say nothing of the other game and the domestic animals killed. Not only this, each mountain lion left at large helps to increase the number of its kind.

Without doubt lions kill more deer in the State every year than all hunters put together. As one man has put it, "a dead mountain lion is worth a living game warden"—meaning that the amount a game warden would save in the way of deer in a year the lion would destroy. To say the least, they are very destructive and good pay should be offered for their extermination. The damage that they do to domestic stock alone is sufficient in itself to warrant the State in paying for their destruction. From the standpoint of game and domestic stock, the

State should add to the present bounty paid by the Fish and Game Commission the sum of $20.00, making a total of $40.00 per head for their destruction.

Taking all things into consideration, there can be no doubt that the coyote is the worst enemy of the small game of the State. On account of their great numbers, and the difficulty of killing or trapping them, they doubtless do more damage than all other enemies combined; including man and the mountain lion. They prey upon nearly every form of wild life from the smallest of birds to the larger animals. They are destructive to all birds that nest on the ground or in the brush, and particularly so to all species of quail. It is probable, also, that they destroy more fawns than all the other animals put together.

The coyote is the greatest obstacle to the introduction into the State of ground-nesting birds. It threatens to prevent the successful stocking of the adaptable areas with wild turkeys, pheasants, and other game birds.

Bobcats also destroy a good many quail, fawns, and other game throughout the year; and in many places foxes are reported as being even more destructive to quail than the bobcats.

Bear destroy deer very rarely, if at all. However, there is a point in this connection which should be mentioned here. Many cases are reported where "bear hunters" go into the mountains during the closed season for deer, for the avowed purpose of hunting bear, but who in reality go for venison. Others who do go for bear, kill deer to feed themselves and their dogs while out on the hunt. In consequence, many of the deputies of the Fish and Game Commission recommend as a protection to the deer, a closed season on bear, corresponding to that on deer. It is to be expected that a proposition to protect bear would meet with disfavor in some portions of the State, where these animals at times destroy hogs, sheep, and goats; however, from the standpoint of the fur industry alone, bear should be protected; but the period for an open season, when the fur and the flesh of the bear are in the best condition—from November to February—would not conform to the open season on deer.

COMMENT AND RECOMMENDATION.

There has been a marked improvement during the past few years in the attitude of the public toward the Fish and Game Commission and the work that it is carrying on. People are coming to realize the value of game conservation both from the æsthetic side and that of dollars and cents.

An effort should be made toward introducing the principles of game conservation into the schools of the State, especially the high schools; for it is through educational sources that the strongest and most effective work is done.

Private game protection deserves favorable comment here. Where land owners have protected deer, the efficiency of the small reserve has been made apparent. In these protected areas the deer have increased and furnished the adjacent regions with good hunting. This is especially true in the coastal counties.

Public sentiment can be developed in various ways—by the work of the police force, and by the example of citizens who have already enlisted their sympathies with the Fish and Game Commission work. The latter is all important, because when once the public supports a proposition, the enforcement of the laws is a comparatively easy matter.

Also a tremendous amount of influence can be exerted through the press of the country. In general, the public is quite impressionable when topics relating to fish and game are discussed. On this account many articles having absolutely no value, and containing false statements, may do a great deal of harm to the interests of fish and game. The State Fish and Game Commission should lose no opportunity to have put into print at all times all the data possible, and especially to correct the fallacious statements of certain individuals, who, if called upon to prove their statements, would soon stop their attacks.

The last, but by no means the least, important topic to be mentioned is that of the game reservation. If we look to the older countries of the world we find that most of them have resorted to the principle of the game reservation as being the essential feature in game conservation. We, in California, may say that this practice has not been nor is it now necessary. But this is a mistake. Now is the time to establish the game refuges before the game becomes exterminated in large areas. Wild game, like domestic animals, must have plenty of room and protection—retreats where it can seek shelter the whole year round, and breed undisturbed. The National parks and the private enclosures where game has been protected in the State certainly demonstrate the value of the reserve. Game will increase in the reserve up to a certain limit, after which it will spread into the surrounding country.

The cost of establishing game reserves and defining their boundaries is but small; and the returns would, in a short time, amply justify the expenditure. Once established, the state or nation must protect the game thereon; shooting must be prevented at all times; violators of the law must be punished; and predatory animals must be exterminated or kept down, this being an extremely important consideration.

The refuges should include forest or desert lands or both. There are many large tracts in California, almost unfit for anything else, that are excellent regions for game reservations. An ideal system would be to create such reservations all over the State, in close enough proximity that game could pass from one reservation to another. Such a commingling of individuals is apt to be of the greatest necessity in the future, to prevent the natural outcome of inbreeding, which might result among isolated groups of animals or even birds.

Even though private interests are accomplishing much along this line, the State should set aside a number of reservations where there would be no hunting at all; and there should also be set aside large tracts of land where every man or woman who so desires may go to hunt. The great criticism that can be made of the older countries is that they have allowed the game to drift into the hands of a few. We should guard against this and retain our game for the people of the whole State, in fact as well as in theory. California has opportunities for establishing a great game system that are almost unequaled anywhere else in the world, and we should not fail to avail ourselves of them. There are vast areas of desert and forest lands now open to the public, and there should be reserved to the people of the State their right to continue hunting upon a very large portion of this area.

The thousands of city people who go into the country every summer to regain and build up their health, even without rod and reel or firearms, greatly prefer to visit regions where the natural features are not effaced; where the forests still stand, and where birds and animals still prevail. It is as much their right to enjoy these creatures living as it is the hunter's right to gratify his desire for slaying them or preserving them as trophies of his skill; and they should have an equal chance to do so. The game refuges fulfill the requirements of the visitor, while the hunting lands supply the hunters with the features that appeal to them.

The principle of the reservation proposition is ideal; the practice of it, thoroughly effective and satisfactory, as has been many times demonstrated in this State, in eastern states, and in other countries. All possible arrangements on the part of the State, counties, and private parties, should be undertaken to encourage the needed establishment of game reserves in California.

THE PRESENT AND FUTURE STATUS OF THE CALIFORNIA VALLEY QUAIL.

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During the past year several circulars have been issued by the Bureau of Biological Survey of the United States Department of Agriculture calling attention to the fact that certain of our native birds, and especially the game birds, appear to be diminishing in numbers. In the annual report of the Chief of the Biological Survey for 1911 this statement is made: "The quail and prairie chicken are favorite and legitimate objects of pursuit by sportsmen, but they have been so ruthlessly pursued that they are now generally scarce and in many localities practically extinct."

With the present agitation in regard to the conservation of our national resources, it naturally follows that sportsmen as well as others are becoming deeply interested in the conservation of game. California has been so well supplied with game that she has been rather slow to wake up to the fact that she must needs look to the future in this regard. The past two decades have seen the practical extinction of such big game as the grizzly bear, elk, and prong-horn antelope. Sharp-tailed grouse have not been seen in the state for many years, and the grouse and sage-hen have been greatly reduced in numbers in many parts of the State.

In line with this rise of interest in game conservation has followed much discussion as to the present status of the California valley quail. The general opinion is that these birds have greatly decreased in numbers. It is the purpose of this paper to present what knowledge we have as to the present status of this quail in California, to discuss the factors governing the increase or decrease of birds in general and of these birds in particular, and to offer, if possible, some suggestions as to ways and means of conserving this valuable game bird.

The sincere thanks of the writer are due Professor C. A. Kofoid, Professor J. C. Merriam, Professor W. E. Ritter, and Mr. Joseph Grinnell, of the University of California, for their helpful criticism and suggestions during the preparation of the present paper.

Three different species of quail are found within the confines of the State of California, the mountain quail (*Oreortyx picta*), the California valley quail (*Lophortyx californica*), and the Gambel or desert quail (*Lophortyx gambeli*). The first is distinctly a high mountain bird and is seldom found below 3,000 feet elevation. The Gambel quail is known only in the southeastern part of the State, where it replaces the valley quail on the desert. The California valley quail is by far the most abundant of the species. Three geographical races, or subspecies of this species, varying slightly in color, are recognized. As these races do not differ in habits they are not distinguished in this paper.

It is always a difficult matter to obtain any adequate idea of the numbers of any species of bird because, as a rule, little reliance can be placed on the opinions of different observers. What might seem a large number to one observer might seem a very small number to another. In order that some idea of the numbers of quail at the present time, compared with the numbers of several years ago, might be obtained, the Fish and Game Commission sent out lists of questions to its deputies throughout the State. By plotting the reports of the deputies on the map of the State, it is easily seen that the two places where there is a consensus of opinion that quail have decreased, are southern California and the upper part of the San Joaquin Valley. (See map, fig. 1).

The reason for the decrease in these particular localities can easily be traced to the hunter. Southern California is well populated and has at least a due proportion of hunters, as is shown by the sale of hunting licenses. The hunting grounds easily accessible from the bay cities naturally show a decrease also. The intensive cultivation in these same localities causes a destruction of food and cover, essential to the maintenance of quail. The answers also show that whereas in some localities there has been a decided decrease, in other localities the birds have either held their own or have increased. Since many of the deputies have only been acquainted with their particular locality for ten years, the records, in most cases, give an idea of the status for this length of time only.

When descriptions of the numbers of quail existing twenty years ago are compared with present conditions, it must be admitted that there are many less quail at the present time. Mr. T. S. Van Dyke, writing in *Outing* in 1890, says: "The statement may seem extravagant, but for many years it was a simple matter for a good shot to bag 200 in a day, all at single shots on the wing. For several years market shooters shipped an average of 10,000 apiece for the season. This hoggish work, with the number crippled and finally killed, has greatly reduced their numbers."

Mr. C. H. Shinn, writing in the same year, in giving the records of two hunters at San Diego, says: "In eighteen consecutive hunts the smallest bag consisted of 47 quail and 5 rabbits; one of the largest bags comprised 187 quail, 8 doves, and 1 rabbit, and no less than six bags ran far above a hundred quail. A Coronado gentleman shot on the wing twelve dozen quail, and a friend with him six dozen. The best bag that this first gentleman has made in San Diego County consisted of twenty-two dozen. They go in flocks of 50 to 800 and when a sportsman has studied the lay of the ground and knows the habits of the bird, he can invariably follow up the same flock with little trouble, until he has flushed and shot the greater number. There is no danger of exterminating the quail on these dry ridges, where there is so much prickly pear cactus, in which they take refuge; and as long as the breeding season is protected no diminution in the autumn and winter quail shooting will ever be observed. I find that even on the valley farms of Alameda County the quail breed in the willows, and flocks of from 50 to 100 maintain themselves in many of the orchards, and have done so ever since the occupation of the region by Americans, though, of course, shot down to a mere handful each winter."

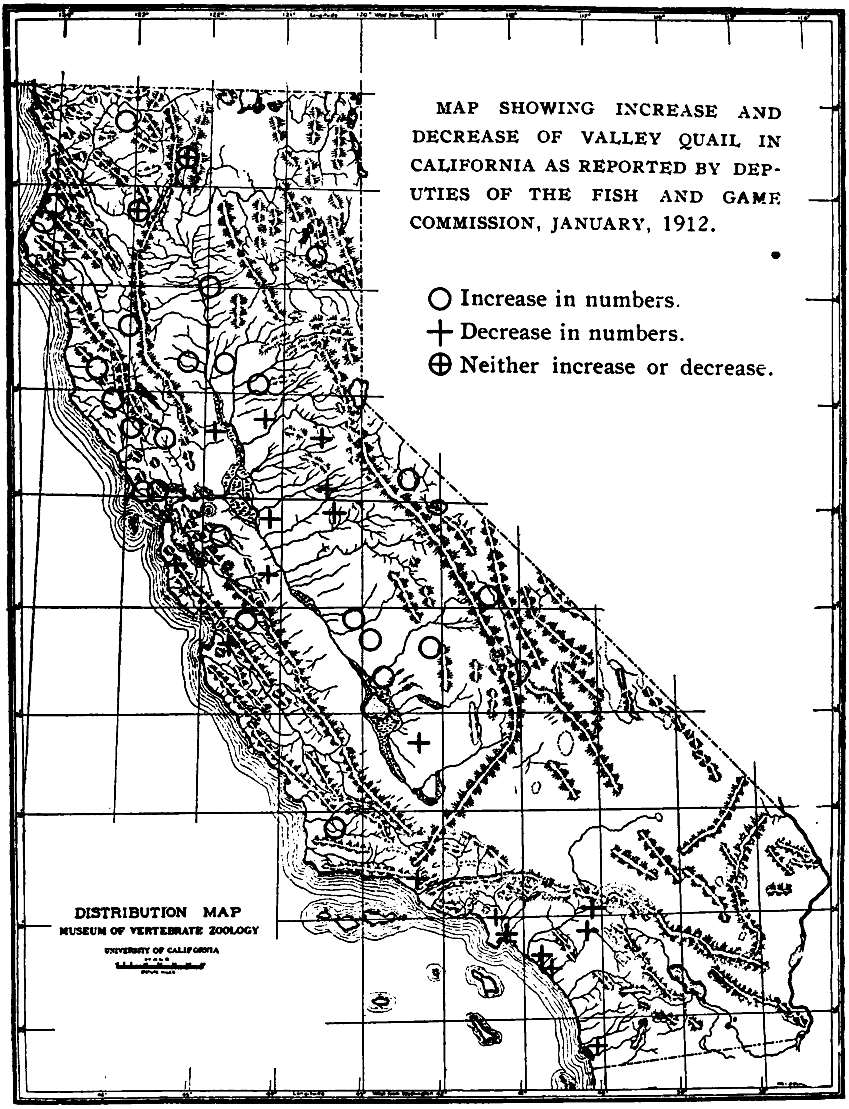
MAP SHOWING INCREASE AND DECREASE OF VALLEY QUAIL IN CALIFORNIA AS REPORTED BY DEPUTIES OF THE FISH AND GAME COMMISSION, JANUARY, 1912.
○ Increase in numbers.
+ Decrease in numbers.
⊕ Neither increase or decrease.
DISTRIBUTION MAP
MUSEUM OF VERTEBRATE ZOOLOGY
UNIVERSITY OF CALIFORNIA

FIG. 1.

In his report on the "Birds of the Death Valley Expedition," Fisher says of the valley quail: "Throughout the San Joaquin Valley Mr. Nelson found it common about ranches, along water courses, or near springs. It was especially abundant at some of the springs in the hills about the Temploa Mountains and Carrizo Plain. In the week following the expiration of the closed season two men, pot-hunting for the market, were reported to have killed 8,400 quail at a solitary spring in the Temploa Mountains. The men built a brush blind near the spring, which was the only water within a distance of twenty miles, and as evening approached, the quail came to it by thousands. One of Mr. Nelson's informants who saw the birds at this place, stated that the ground all about the water was covered by a compact body of quails so that the hunters mowed them down by the score at every discharge." This was in 1893. Last summer and in April of this year parties from the Museum of Vertebrate Zoology of the University of California visited the same general locality, reporting that either none or but very few were to be seen at the watering places.

These quotations give a fair idea of the point of view of competent men twenty years ago. It is needless to call attention to the fact that in the very places mentioned by these men, conditions have changed and that quail are not nearly as numerous as they were twenty years ago. In many places in the State, nevertheless, where there is little intensive cultivation, the protection afforded them the past few years has allowed them to hold their own and in some places to increase.

Having now pointed out the fact that quail have greatly decreased in numbers in some parts of the State and have apparently increased in numbers in other parts, let us pass on to a discussion of the factors governing the increase and decrease of birds in general and of quail in particular. Professor S. A. Forbes was one of the first to point out the importance of studying the natural order as a whole, and understanding the disturbances to which it is subject. In a paper entitled "On Some Interactions of Organisms," he says: "While the natural order is directed to the mere maintenance of the species, the necessities of man usually require much more. They require that the plant or animal should be urged to superfluous growth and increase, and that all the surplus, variously and widely distributed in nature, should now be appropriated to the supply of human wants. From the consequent human interferences with the established order of things numerous disturbances arise,—many of them full of danger, others fruitful of positive evil. To avoid or mitigate the evils likely to arise, and to adapt the life of his region more exactly to his purposes, man must study the natural order as a whole and must understand the disturbances to which it has been subject. Especially he must know the forces which tend to the reduction of these disturbances and those which tend to perpetuate or aggravate them, in order that he may reinforce the first and divert the second."

There are at least six factors that have a direct influence on the numbers of any species of animal, the importance of each varying greatly according to locality. They are as follows: Food supply, cover, predatory animals and birds, disease, weather conditions, and the hunter.

There is an old biological law which states that birds and animals under natural conditions will increase up to the limit of their food supply. On any given area there is food and protection for a certain population of plant and animal life. Just as soon, therefore, as the food or protection or both are diminished the given area will support less numbers of individuals and vice versa. This law is one of the most fundamental of all natural laws and most of the fluctuations of numbers of a given species can be traced either directly or indirectly to the working out of this law. Such factors as disease, predatory animals and birds, and climatic conditions are usually minor external factors. If it can be shown, then, that the food supply or cover of the California valley quail has greatly decreased in the last twenty years, we should naturally expect a decrease in the numbers of quail. If, on the other hand, it can be shown that the food supply and cover, or both, has not decreased, or has increased, we should naturally expect to find the quail holding their own or increasing in numbers; that is, barring other factors such as disease, an increase of predatory mammals and birds, or hunting. Outside disturbances in the balance, such as the hunter, may or may not have a decided influence on numbers, depending upon the extent of the destruction. A certain small amount of destruction probably would have little or no effect on the numbers, as this depletion would simply leave more room for others and a larger per cent of the birds hatched would live.

Under natural conditions, therefore, the food supply of a bird probably has more to do with the numbers than any other thing. The cultivation of land, which is becoming more and more general each year, causes the destruction of the natural food of many of our birds. In a few instances certain birds are profiting by a new supply of food furnished by the crops raised; but in most instances the intensive cultivation of land brings a diminution in the numbers of birds very largely due to a destruction of their natural food. It is pleasing to note that the quail are among the birds which have, to some extent at least, adapted themselves to the new conditions. It has been stated that no birds flourish under so many varied conditions as do the California valley quail; for they can be found from sea level to a mile above the sea, and from the humid coast belt to the desert. They have been found breeding in tules, in vineyards, in the weeds along fences, in orchards, and even in suburban gardens. Vineyards furnish them not only acceptable food but good cover. The quail being largely a seed eater, will turn to grain, grapes, and other cultivated products when its natural food is not available. In spite of this fact, however, the cultivation of great tracts of wild land accompanied with the destruction of such plants as the burr clover, alfilaria, lupine, tarweed, pigweed, and mustard, has diminished the food supply of the quail to such an extent that doubtless it has had a considerable effect on the numbers.

The habits of the quail show them to be closely dependent on cover. There are many places in the State where it could be definitely shown that the destruction of cover has been the primary factor in the diminishing of the numbers of quail. Not only is that cover, destroyed in the clearing of land, of importance, but also the large areas destroyed by fire each year. As the land becomes cultivated, but a small amount of cover is furnished in place of that destroyed. The weeds and shrubs growing along the fences, and the vineyards, probably furnish the best of the new cover.

In some parts of the State the pasturing of sheep is having a direct influence on the quail. Belding, in his "Birds of the Pacific District," written in 1890, speaks of the valley quail as follows: "Rather rare at Red Bluff where much of the country is used for pasturing sheep. Formerly very abundant in the Marysville Buttes but now rare for the same reason. Not only do sheep destroy nests by treading on them, but they prevent the growth of cover, and this timid bird deserts her nest where there is the least cause for so doing." The pasturing of cattle is doubtless a menace to quail in many parts of the State also.

A certain number of quail are claimed each year by predatory mammals and birds. The wildcat, coyote, fox, and skunk are probably the worst offenders among the mammals, and the Cooper, sharp-shinned, and duck hawks, the worst among the predatory birds. The bluejays, the roadrunner, and the gopher snake are reputed to destroy eggs and young. Under natural conditions these predatory mammals and birds were far more numerous than they are at present so that they cannot be considered a very serious factor in the decrease. It seems reasonable to believe that the slaughter of these mammals and birds has kept up with the destruction of the quail so that there is certainly no larger a toll now than formerly. In fact, there is probably a less toll taken by predacious mammals and birds at the present.

Quail appear to be little subject to disease. As far as can be ascertained there is no reference in literature to an epidemic appearing among California valley quail. Certain parasites are not uncommon in these birds, however. Mr. Joseph Mailliard gives his experience with parasites in valley quail in the following words: "In Marin County, if my memory is correct, in San Benito County also, these birds are frequently found with what appear to be small tapeworms, or with numbers of round, rather blunt worms about half an inch long closely resembling those sometimes found in domestic poultry. Besides I have often found a group of exceedingly small parasites of a bright vermillion color, suggesting fungoid growth, around the vent, but have never examined these with a microscope." Chas. S. Thompson has also called attention to the fact that he has found tapeworms in quail. He says: "At least one third had tape worms two and one half to four inches long in the intestines." The presence of such intestinal parasites is not as a rule very detrimental to the health of the animal, practically all mammals and birds and even man being attacked to a greater or less degree.

In 1906–7 large numbers of bobwhite quail kept in captivity died with what was called quail disease, a disease singularly like the grouse disease of England. At that time post mortem examination showed the presence of quail disease in the common bobwhite, the California quail, the Gambel quail, the scaled quail, the mountain quail, and the sharp-tailed grouse. The prominent symptoms were first dullness, and then emaciation. Only birds kept in confinement were found infected.

Bobwhite quail kept in captivity have been found infected with coccidiosis, a disease which sometimes attacks poultry. This disease seems to be a common one among birds, for it has been found in grouse, pheasants, pigeons, and is quite a common disease among domestic fowls, especially turkeys here in California. The Committee on Grouse Disease in England, in an elaborate report this past year, shows that one of the diseases which has destroyed such large numbers of grouse in England and Scotland is coccidiosis. Another disease caused by threadworms (*Nematodes*), called strongylosis, has also been instrumental in destroying large numbers of these birds. Coccidiosis is a serious disease, the birds attacked by it usually dying from the effects. Whether California valley quail under natural conditions have ever been known to contract the disease I have not been able to ascertain. Such a protozoan disease as this, if it should attack our quail, would doubtless prove a serious menace; but fortunately there seems to be no immediate danger. At the present time, therefore, disease cannot be considered an important factor.

Weather conditions perhaps have more effect on birds which nest on the ground and on birds with the habits of the quail than on other birds. T. S. Van Dyke says on this point: "Extreme drouth is the only natural thing that reduces them. They increase enough to supply the hawks, foxes, wildcats, and owls, and can stand even a reasonable amount of shooting. But when the winter rains fail to make seed enough for its ravenous appetite, this quail knows well before too late. It then declines to mate and remains all summer in the big armies of the preceding year." That quail are able to foretell weather conditions and shortage of food is doubtful; but the fact that quail sometimes remain in flocks during the breeding season has been noted by other observers. Even here we see that the weather conditions are only concerned because they affect food supply.

Inbreeding is sometimes put forth as a reason for decrease, but it can hardly be substantiated by fact. Chickens are often known to inbreed for long periods of time without any apparent diminution in vitality or productiveness. Besides, the quail wander over large enough areas so that there is little danger of effective inbreeding. Then, too, there is no good reason why there should be very much more inbreeding now than there was twenty years ago when every one admitted that quail were in a thriving condition. The fact that quail, even in places where there were small numbers, have greatly increased under sufficient protection, seems in a measure to disprove this theory. Quail being nonmigratory, isolation caused by the cultivation of large tracts of land would bring about favorable conditions for inbreeding. The extent to which such isolation could be brought about by intensive cultivation is problematical. The question awaits future development, and so further consideration at this time is not pertinent.

Last, but not least, comes hunting as a factor in the increase or decrease of birds. In many places this has been the most important factor in causing a decrease in numbers. With the increased traveling facilities, and the increased efficiency of firearms, this aspect of the question is yearly becoming more and more important. Twenty years ago hunting involved not only considerable time but considerable inconvenience; to-day, with the automobile and the increased transportation facilities, a hunt involves but little time and almost no inconvenience. The comparative destruction possible with the muzzle-loader or even with a single-barreled breech-loading shotgun, and an automatic, brings forcibly to mind one of the causes for the decrease in game birds during the last few years. Shooting from automobiles, a practice of the present day, is an easy way of filling the game bag but is a dangerous practice when viewed from the standpoint of conservation. Most game birds, on account of their prolificness, can withstand a certain amount of shooting; but the wholesale slaughter, now made possible by improved methods, undoubtedly oversteps the danger point.

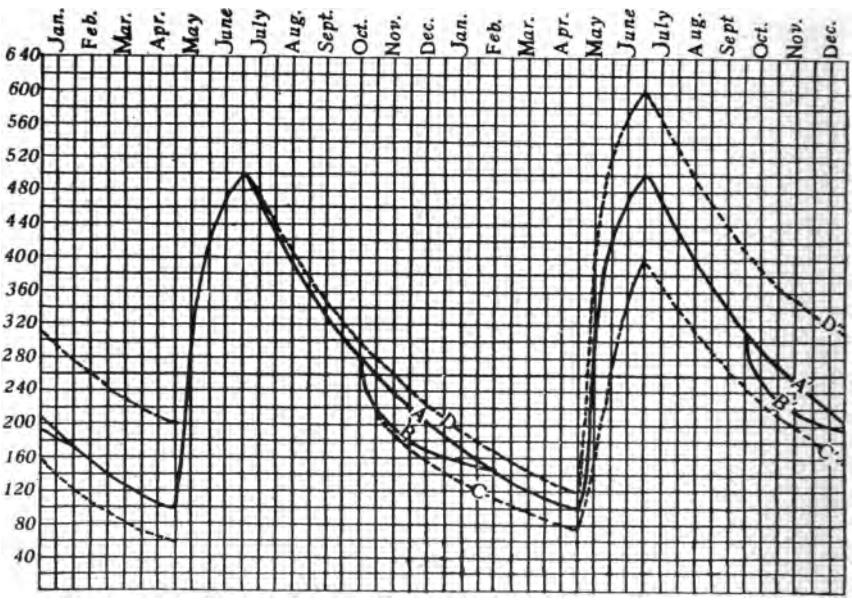

Fig. 2.

The geometrical ratio of reproduction of plants and animals is large enough to necessitate an increase in numbers were it not for adverse circumstances. For example: The female of each pair of quail, judging from records, lays an average of twelve to fifteen eggs. Various dangers, however, probably prevent the hatching of more than an average of ten young. If all of these young should survive and reproduce, at the end of the second year there would be 132 quail for every original pair. But we know that this is not the case, but that there is usually about the same number each year. This means that the death rate must equal the birth rate, and, in the case of the California valley quail, the death rate must be some five times as great as the normal minimum population. Or, in other words, the life rate, or rate of survival, must be only 2 out of every 130 quail.

Taking a covey of 100 quail, probably at least 40 of that number would average a brood of ten young each year. This would mean that just after the hatching season, there would be something like 500 quail where there had been 100. At the opening of the next breeding season this covey, under natural conditions, would have been reduced to 100 again. Evidently therefore, there would have been a mortality of about 400. There are a great many factors to account for this immense mortality, chief among them being, under natural conditions, lack of food supply and destruction by predatory mammals and birds.

If we make a hypothetical curve, the points to be brought out are made intelligible. If along the left-hand side of the graph (Fig. 2.) are plotted the numbers of individuals, and along the top, the months of the year, the maximum and minimum numbers would form a curve such as is seen in A. The minimum numbers can reasonably be expected to exist just before the eggs are hatched, say early in May. Let this minimum number be represented by 100. By the end of June, just after the hatching season, the maximum numbers would naturally be found. From this time on there is to be expected a decrease in the numbers until the minimum of 100 is again reached. The weaker members of the flock will be killed first, and those which can survive till the later part of the winter will have then a far better chance of surviving till the breeding season. Hence, the curve drops quickly until February is reached, thus showing a greater mortality during the fall months. At the end of hatching, if forty per cent produced an average of ten young, we find the numbers of quail increased from 100 to 500. At the beginning of the hatching season the next year, however, this number has again been reduced to the minimum number of 100. It can be seen then, that, under natural conditions, we are to expect, with a covey of 100 quail, that nearly 400 could be destroyed each year and yet equilibrium would be maintained and the birds would not decrease in numbers.

Suppose that we introduce a new element, shooting. A certain number of birds would still be claimed by the natural forces at work; but if the shooting occurred during the open season, October 15th to February 15th, a certain proportion of the birds shot would be birds which would later have died from other causes, and just so long as that particular percentage was not greater than the death rate for that period of time there would be no decrease in numbers (curve B).

Of course a certain number of those vigorous birds destined to survive and breed would be claimed by the hunter. Under proper regulations these might be but a small per cent, however, and even the killing of these might make the struggle for existence of less vigorous individuals so much less that their chances of surviving would become greater. Let the number shot bring down the numbers of birds to 75 instead of 100 at the time of minimum numbers, however, and a decrease would necessarily follow in the next year's crop of young (curve C). It seems probable, moreover, that with the hunter, just as with predaceous animals, the least vigorous prey is most easily obtained; so that no selective deterioration of the quail stock can be attributed to the hunter.

The dotted line C on the graph represents the conditions to be expected from an excessive amount of shooting. If the death rate could be lessened, the condition represented by D would exist, that is, there would be an increase in the numbers of quail. Such an increase could not exist for long, however, for the struggle for existence would also be increased to such an extent that a normal would soon be established. This same type of reasoning has been applied to nearly all forms of life and has been found to hold true.

Summing up, then, we can say that *a certain amount* of shooting might in no way affect the numbers of quail; for in the shooting we might be simply making use of numbers of quail that would have perished in some other way. It should be kept in mind, however, that there is a danger point and that when the number killed approaches near to or exceeds the normal death rate, there must follow a decrease. Another point to be remembered is that this reasoning applies to ideal conditions and does not mean that 400 out of every 500 quail can be killed each year. In shooting, many birds are killed that would have survived till the breeding season; and herein lies an error in the computation that must be taken into account. Probably the number that it would be safe to kill would be very far under the 400 mark; but even then the number might be large enough to allow considerable hunting. It is safe to say that quail can withstand a certain amount of shooting without showing a decrease in minimum numbers, the exact amount being dependent largely on the death rate and consequently on the locality. The great danger of exterminating the quail by hunting lies in the excessive amount of shooting which is seen in certain parts of the State, brought about by the use of improved firearms and the augmented number of sportsmen.

As can be seen by studying the graph, the open season should come during the winter months,—after the young have become full grown, and at the time when the natural mortality is large. A lengthening of the season to include too many of the late winter months would result in the destruction of those birds most necessary for the retention of normal numbers. Fall shooting would allow the killing of half-grown birds. Winter shooting, *if kept within bounds,* will permit the quail not only to hold their own but to increase. The months of November and December seem best fitted for the open season. A shortening of the season to these two months would doubtless improve conditions in many localities.

The present bag limit may be too large in some parts of the state, especially in those parts where the quail are known to be on the decrease. The closing of the season for a few years, or the creation of a weekly bag limit, might be sufficient to improve the status of the quail in these particular localities. Shortening the season too much only concentrates the shooting and seldom improves conditions. The creation of a weekly bag limit, or the closing of the season for a brief period of years would effectively cut down the toll taken by the hunter. Where there is a marked depletion in numbers the closing of the open season seems the most sensible way of meeting the situation.

The suggestion that the new blood is needed is hardly borne out by the facts already brought out. Our native stock is apparently in good health and only depleted in numbers.

A study of local conditions affording a knowledge of the death rate seems the most scientific way of dealing with the problem, and this method will doubtless be the method used in the future. When the amount of shooting is regulated by the natural death rate there will be no diminution in numbers of the California valley quail on account of the hunter. It should be remembered that the hunter is probably one of the most important of many factors governing numbers, and that the only way to quickly increase numbers is to cut down the toll claimed by the hunter.

SUMMARY.

California valley quail have been greatly reduced in numbers in some parts of the State. In other parts these birds have increased in numbers during the last ten years, whereas in still other parts their numbers have neither decreased or increased.

Many factors govern the increase or decrease of birds, chief of which are: Food supply, cover, predatory mammals and birds, disease, and the hunter.

Food supply is probably, in the last analysis, the most important of the factors governing numbers under natural conditions, for it is a well-recognized fact that both animals and plants will increase up to the limit of their food supply.

Predatory mammals and birds act as a check on the numbers of quail and their destruction allows of an increase, but this factor having conditioned the quail population for so long a time is of less consequence than other factors.

As there are no records of an epidemic of disease among California valley quail, there seems to be little immediate danger from this direction. "Quail disease" and "coccidiosis," well known diseases of other members of the quail family, present a grave danger, however. A knowledge of the extent to which valley quail are immune to these diseases would throw valuable light on this subject.

The average hunter, although almost a negligible quantity twenty years ago, on account of the improved facilities for transportation and the improved firearms, has become a very important factor. A study of the laws of nature governing the numbers of quail shows that this bird might be able to withstand a small amount of destruction during the winter open season without danger of impairing the average numbers from year to year. It is when the destruction during the year nearly equals or exceeds the annual crop, thereby destroying the productive brood stock for another year, that the danger point is reached. A regulation of the amount of shooting based on the scientific determination of the normal death rate of the young and adults will eliminate all danger of the extermination of this bird by the hunter. A serious danger also, doubtless lies in the modification and destruction of the food and cover of this bird contingent upon the settlement of the country.

The present status of the California valley quail calls for conservative action, governed by a knowledge of those factors causing a disturbance of the balance. In other words, strengthen those factors which cause an increase in numbers and weaken or destroy those factors which cause a decrease in numbers, and the quail will become subservient to our interests. The furnishing of plenty of food and cover, either by artificial feeding and planting, or by game preserves, the destruction of predatory mammals and birds, prevention of disease, and careful regulation of the amount of hunting to permit of the survival of a sufficient number of the productive brood stock to insure an undiminished annual crop, are factors within our control and on these depend the future of the California valley quail.

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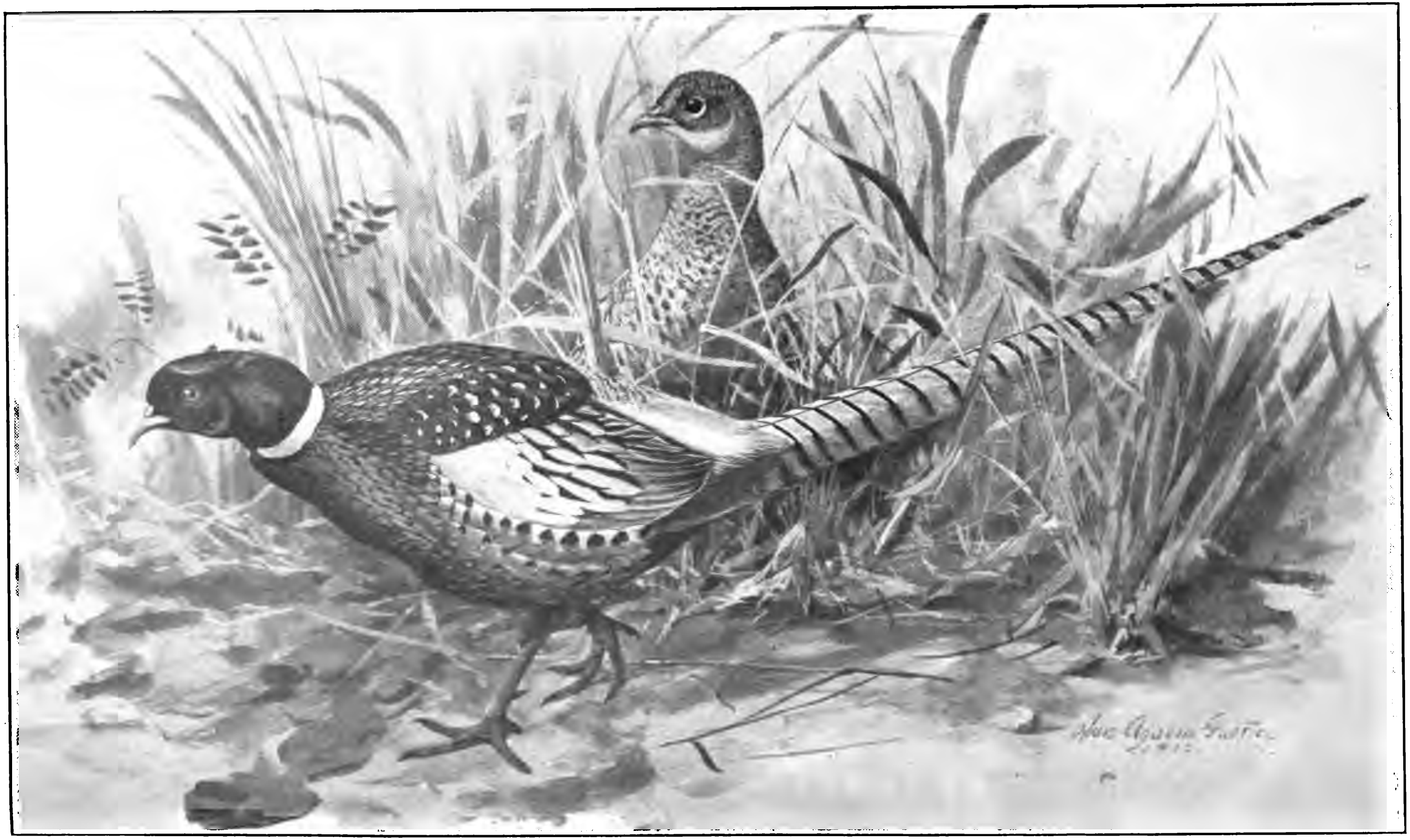


Ring-necked Pheasant (*Phasianus torquatus*).

INTRODUCTION OF FOREIGN GAME BIRDS INTO THE SOUTHERN SAN JOAQUIN AND TRIBUTARY SECTIONS.

By A. D. FERGUSON,

Deputy in Charge Fresno Division.

From the inception of the Fish and Game Commission's plans to establish new and desirable varieties of game birds in the State, a lively interest has been manifested by the people of this division. Many applications for partridges, pheasants, and wild turkeys have been received, and many plants of such game birds have been made in various sections of the Fresno Division where the natural conditions seem to favor the success of these experimental plants. Careful inquiry on the part of the Commission's deputies would indicate that while in certain sections the ring-necked pheasants have established themselves in a satisfactory manner, and while favorable reports have been received in regard to the wild turkeys, the results of the experiments in setting out Hungarian partridges are wholly discouraging. The Hungarian partridges set out by the Fresno office at the Roeding vineyard, six miles east of Fresno, were seen in that vicinity for a few days, and thereafter disappeared. Like conditions have been noted in other sections of the vineyard country. One of the earliest experiments in setting out Hungarian partridges was undertaken on the Chowchilla Ranch, in the southerly part of Merced County. This ranch comprises many thousand acres of wild lands, much of it swamp land and timber land. Of this plant Mr. Isaac Bird, manager of the Chowchilla Ranch, writes:

"MERCED, CAL., Oct. 5, 1912.

"*Mr. A. D. Ferguson,*
Fresno, California.

"DEAR SIR: Replying to your letter of the 26th ultimo, I have no doubt but that the Hungarian partridges we liberated here several years ago have entirely disappeared from this locality, as they have not been seen for a long time, at least; and in fact I have grave doubts as to their ever having been seen later than a few days after we turned them out, as I did not see them myself and have had no very reliable information as to anyone else having seen them. Several of our men have reported to me as having seen them, but on investigating the matter have always found it was a mistake, and that they mistook other birds for them. I think they left here immediately after they were liberated, probably going to the mountains or away to some one of the rivers. I am positive they are not here now, nor have they been for a long time at least, but further than this I cannot say.

Yours very truly,

(Signed) ISAAC BIRD."

A favorable report comes, however, from Mr. Wingrove of Hot Springs, and it may be that the birds liberated in the valley have made their way to the mountain sections and may later appear in numbers where they have not been looked for. Mr. Wingrove's letter follows:

"HOT SPRINGS, TULARE COUNTY, CAL., November 1, 1912.

"*Mr. A. D. Ferguson,*
In Charge, Fresno Division Fish and Game Commission, Fresno, Cal.

"DEAR SIR: Will state that a short time ago I heard of a good large bevy of Hungarian partridges about a mile and a half from the springs, on one of the branches of Deer Creek, near the vicinity where we planted these partridges about three years ago. A year or two ago also heard of a bevy of young partridges near our ranch on White River, where we planted a couple of pair of these birds three years ago. These birds were seen in very wild and covered brush country, which would indicate that they take more to the brush than open country.

Yours very truly,
(Signed) L. S. WINGROVE."

Among the orange groves in Tulare County, ring-necked pheasants liberated by the Commission have apparently taken kindly to their new environment. Particularly in the Porterville section many pheasants may now be seen. It is estimated that some eight hundred pheasants are now in the immediate vicinity of Porterville, being the increase from a small plant made some years ago. Repeated efforts to establish the pheasants in the vineyard section of Fresno and adjoining counties have not proven successful. A consignment of about one hundred birds was early in this year sent to the Kings River bottom, east of Sanger, in Fresno County, where by reason of the co-operation of all of the ranch owners in that section, and of the apparently suitable conditions with regard to natural food, water, and cover, it is hoped better success will be met.

Some new and interesting light has recently been thrown upon the situation by the discovery of small covies of pheasants in the high mountains of Fresno and Tulare counties, at elevations of from 5,000 to 8,000 feet, and 40 miles or more from the point where the birds are known to have been released. Encouraged by these reports, the Commission has recently made some strong plants of ring-necked pheasants in carefully selected regions of Fresno and Tulare counties, at elevations of 3,500 feet or more. It is possible that the pheasants may yet be established in the higher altitudes of the central portion of the State.

WILD TURKEYS.

Although found naturally in the mountains of Mexico and in Arizona, the distribution of the wild turkeys of western America apparently has never extended into California. A reasonable explanation may be found in the wide expanse of desert between their northernmost range and the well watered and well timbered Sierra and Coast Range mountains of this State. The theory of an arid or a timberless region of vast extent being a bar to the extension of the range of the species offers sufficient ground for the belief that climatic conditions in certain sections of California may not prove unfavorable to the existence of wild turkeys. The western slopes of the Sierra Nevada Mountains must always remain to a great degree in their present primal condition, thus offering to any adoptable form of bird life a permanent habitat. Should the winter climate of the higher altitudes prove too severe for the welfare of wild turkeys, a comparatively short migration would bring them into the foothill section where, at altitudes of 2,000 to 3,000 feet, little or no snow would be encountered, whilst isolation from civilization would still be assured. If the wild turkey can be successfully introduced into the Sierra Nevada Mountains, it probably would not be to the detriment of any of our native birds, but would, on the other hand, prove a valuable acquisition.

Mexican Wild Turkeys in the Southern Sierra.

A great deal of interest has been manifested on the part of the people generally in the Commission's effort to introduce wild turkeys into suitable localities. It is a matter of great satisfaction to note the enthusiastic and active coöperation given the Commission by the people of the mountains, wherever the wild turkeys have been introduced. In the first experiments undertaken, a small number of birds was released in a given locality. Believing that the chances for success would be greatly enhanced, the Commission, during the past season, has adopted the policy of making fewer plants, with a larger number of birds in each plant. While the success of the Commission's efforts in the line of establishing these valuable game birds in the wild state is not yet assured, considerable encouragement has been met.

The chief difficulty has been found to be in the depredations of predatory animals. Reared in captivity at the State Game Farm, at Haywards, the wild turkeys, when first released, are not sufficiently wary to wholly protect themselves against foxes, coyotes, and wild-cats. In the Commission's more recent experiments, this difficulty has been largely obviated by stationing a deputy in the vicinity where the wild turkeys have been released; although keeping out of sight of the birds, he has been able to protect them against their natural enemies until they have fairly well adapted themselves to their wild surroundings.

That the birds may more readily take up with the wild state, they are liberated in isolated localities, far from any human habitation. They appear to readily accept the most of the varieties of natural feed of which there is an abundance, particularly in the Sierra Nevada Mountains.

Strong plants of young turkeys raised at the State Game Farm have been made in various parts of the State. Many conflicting reports have been received of their actions after being released. These reports are, no doubt, largely due to the manner in which the birds have been liberated and to the nature of the locality wherein the different lots have been released. Some typical examples are recorded from the fourth fish and game district.

An interesting experiment was successfully tried by Deputy Bullard, to whom had been consigned fifty wild turkeys to be released in the Sampson Flat country, in eastern Fresno County. Observing that the turkeys did not undertake to eat acorns, which covered the ground in great quantity, he macerated several bushels of the acorns and scattered them upon the ground among the unbroken ones. The birds readily ate the cracked acorns and thereafter accepted them in the natural state, to their very great physical welfare.

Some further interesting light on the actions of domestically raised wild turkeys, and upon the temporary protection necessary to be afforded them when released in the wild, is thrown by Deputy Bullard's report. Two coyotes that had evidently located the roosting birds pounced upon them about daylight, as they alighted from the trees, and destroyed three the first morning after the birds were released. The following morning the deputy concealed himself in the vicinity and succeeded in killing one of the coyotes and wounding the second. On this morning the turkeys appeared much more wary than at first, and thereafter did not again roost two successive nights in the same vicinity. On the contrary, they traveled, apparently in search of food, in a circle some five or six miles in diameter. Occasionally the band would be found split up into bunches of from three to ten birds. A few days later, and some miles distant, as many as thirty of the original fifty turkeys might be found together. That the birds did not adopt a permanent roost is no doubt greatly to their advantage as a protection against predatory animals. During the past summer this bunch of turkeys has greatly widened its range and appears to have split up into small flocks. Some of them have been seen in General Grant National

Park, a distance of some ten miles from the point where they were originally liberated, but none of the birds has ever attempted to return to the domestic state, although in their migrations they must have passed very near to some of the ranches which dot, at wide intervals, that section of the mountains.

That it is inadvisable to free young wild turkeys which have been reared in captivity too near to civilization, was shown by the conduct of a flock of 50 birds sent to Tuolumne County, in November, 1911. Released near "Cave Diggings," and food conditions being probably not to their liking, this lot promptly moved some two miles to a barnyard. They were afterwards captured by Deputy Scott and some other interested citizens, and taken to an isolated section at Hunters Bend, on the Tuolumne River; here the turkeys settled down, and when last reported, they appeared to be thriving.

In October, 1911, a small consignment of wild turkeys was delivered to Mr. J. D. Blick, at his stock ranch on the South Fork of the Kaweah River, south of Sequoia National Park. These turkeys having taken up their abode about the ranch buildings and a number of hens having nested, Mr. Blick conceived the plan of hatching the eggs in an incubator and thereafter releasing the young birds in some isolated locality, his idea being that if turned out before they should have become too thoroughly accustomed to civilization, the young turkeys would more readily take up with the wild state. Accordingly, an incubator was furnished Mr. Blick, who thereupon undertook to try out his idea. Feed and water conditions in Mr. Blick's section are quite favorable, but the presence of large numbers of predatory animals has greatly militated against the success of his experiments. An enthusiastic naturalist of wide experience, Mr. Blick is continuing his efforts, and the final results should be definite, although it as yet too soon to offer a forecast.

In the fall of 1910 a small consignment of wild turkeys was released in the elk paddock of the Sequoia National Park. The result offering some encouragement, but the plant being considered too small for a practical demonstration, in August, 1911, a second consignment of 150 wild turkeys was sent to the park, supplemented in October by some 72 additional fowls. The park authorities had, in the mean time, selected a new location farther back in the mountains, from which they had largely eliminated the predatory animals by persistent trapping. These birds were released at a point known as Hospital Rock, on the Kaweah River, in the heart of Sequoia National Park. The elevation is about 3,000 feet and the fowls may readily seek a greater or less elevation according to the exigencies of weather and food conditions. There is an abundance and variety of natural food, of which may be mentioned wild oats, legumes (four varieties), bunch-grass, deer-brush, alfileria, Rhamnus berries (coffee berries), and nine varieties of acorns, aside from an abundance of insect life. In the sheltered cañon of the

Kaweah River, the natural grasses start early in the spring and being ungrazed by stock, the feed is not destroyed throughout the season. The water supply is never-failing, and since firearms are rigidly prohibited in the park, there is no danger of the destruction of the wild turkeys by the hand of man. Mr. Walter Fry, superintendent of the park, has taken great interest in the effort to establish wild turkeys within the park, and has spared no pains to promote the success of the experiment. Replying to an inquiry, Mr. Fry writes:

DEPARTMENT OF THE INTERIOR,
SEQUOIA AND GENERAL GRANT NATIONAL PARKS.
OFFICE OF SUPERINTENDENT.

THREE RIVERS, CAL., Oct. 7, 1912.

Mr. A. D. Ferguson, Deputy Fish and Game Commissioner, Fresno, California.

MY DEAR MR. FERGUSON: In reply to your favor of the 26th ultimo, relative to the condition of the plant of wild turkeys in the Sequoia National Park, in connection therewith I beg leave to submit the following report:

The turkeys have thriven; while they have not so noticeably increased in number, they are doing well and have hatched several broods during the present year. Many of the first hatch, during the month of February, died from cold, but those hatched later have made rapid growth. The flocks now seem to be concentrating in the vicinity of the Marble Fork River. We have sustained much loss from the effects of predatory wild animals, but are overcoming this evil to a certain extent by killing off the animals.

Trusting this will give you the desired information, I beg to remain,

Very truly yours,

(Signed) WALTER FRY,
Acting Superintendent.

The stock thus far used in these experiments is all of Mexican origin. It is possible that a species better suited to conditions in California might be secured. It should be borne in mind, however, that it is not absolutely discouraging if these first plants of birds fail to quickly show a strong increase. The offspring of young turkeys, whether of the wild or domestic variety, are neither numerous nor are the individual chicks strong. Should these young birds which the Commission has been setting out, escape for two or three seasons their predatory enemies, the time would be ripe to expect an increase to be shown in the size of the flocks or to doubt the possibility of a successful issue of the experiment.

EDUCATING THE YOUNG PEOPLE AS TO THE NEED AND VALUE OF WILD LIFE CONSERVATION.

By Gretchen L. Libby,
Educational Assistant.

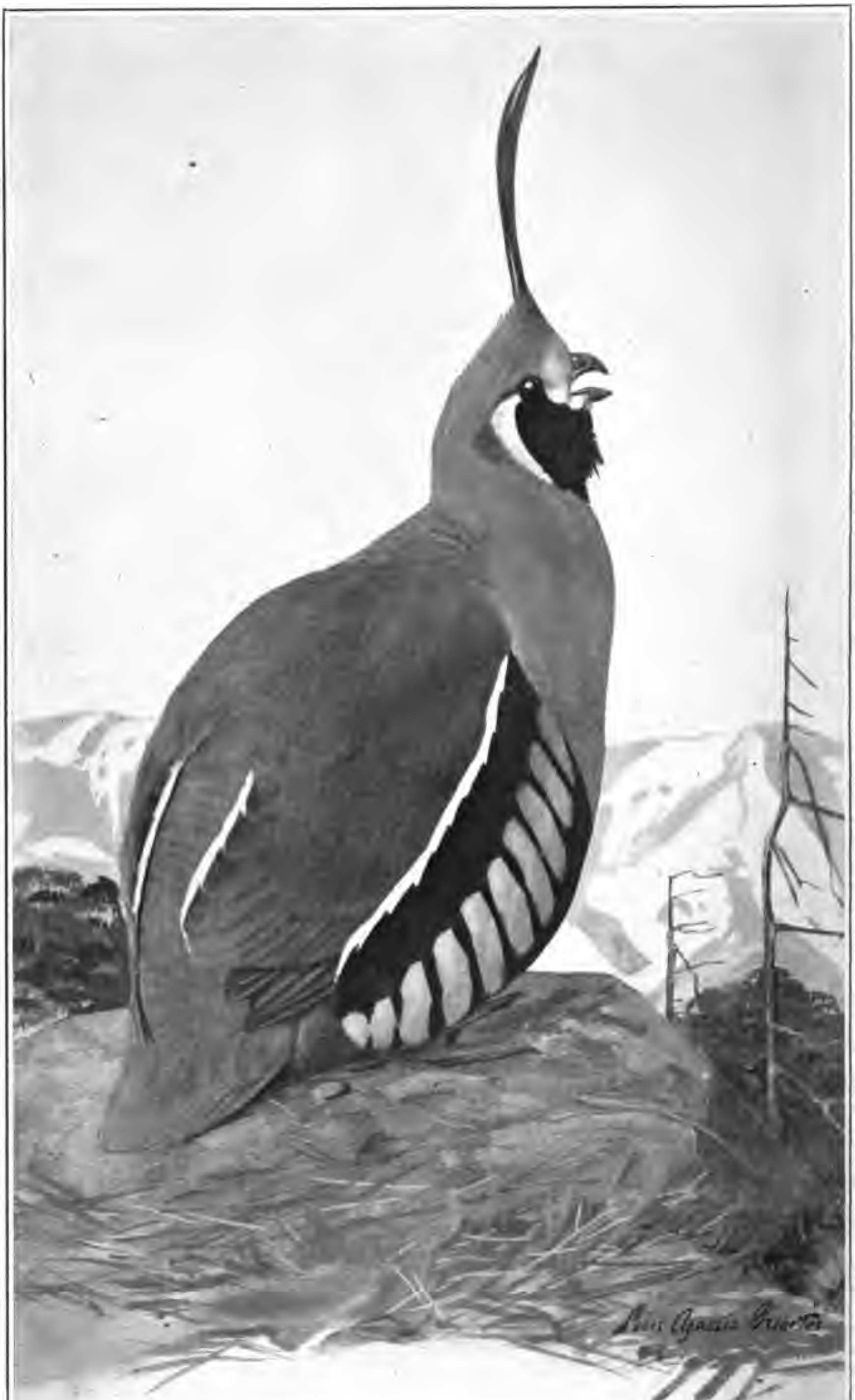
The Educational Assistant of the Commission respectfully submits the following report of the work carried on in the educational department, from April, 1911, when this special branch was first established by your honorable board, to September, 1912.

During this time 557 talks have been given on the following subjects: "The Work of the California Fish and Game Commission in Its Relation to Conservation," "The Economic Value of Birds," "Bird Life in California," "Bird Study in the Schools," and "Our Bird Friends," these talks being illustrated with colored lantern slides, bird skins, or colored pictures. About 37,500 people have been reached in 31 counties, 115 towns, and 230 schools throughout the State, and a distance of 10,000 miles has been covered.

In this way it has been possible to reach practically all classes of people, as this work has included lectures before school superintendents' conventions, school trustees' meetings, teachers' institutes, farmers' clubs, women's clubs, and Young Men's Christian Associations, as well as stereopticon evening lectures for the general public. In the schools the talks have been given to pupils of all ages, ranging from the kindergarten to the normal school and university.

A great deal of correspondence has been necessary, both in arranging for lecture work, and in replying to requests for literature and for general information concerning the work. Besides this, about 3,000 circular letters have been sent out to school superintendents, school principals, and teachers. In June, 1912, question blanks were also sent to all teachers reached by the Educational Assistant during that year; these blanks to be filled out by teachers and returned, thus outlining the work carried on by them. In this way it was possible to get in touch with what had already been done, in preparation for planning the next year's work.

Realizing that there is no better way of educating the people than through the medium of the press, a series of newspaper articles has also been prepared by the Educational Assistant, on the the following subjects, "Conservation of Bird Life and Its Importance," "Food Habits of Birds in Their Relation to Man," "Birds as Weed Destroyers," and two articles on "Birds as Rodent Destroyers." This first series will be completed with an article on "Birds as Insect Destroyers." These articles have been sent out monthly, and have been published in many of the newspapers, and also in some of the agricultural journals, and other periodicals throughout the State, having had a circulation of at least 230,000. Letters have been received from newspaper men in various sections of the State expressing their hearty sympathy with this



Mountain Quail (*Oreortyx pictus*).

phase of the work, and their willingness to co-operate in it. It is the plan to continue these articles during the coming year, taking up various topics dealing with the economic value of bird life in its relation to man.

While some time has been spent by the Educational Assistant in general lecture work, her chief duty has been to give instruction and create an interest in bird life among the teachers and children, by giving talks before teachers' institutes and in the schools of the State. This has been made possible through the hearty co-operation of school superintendents, and much interest has been shown. As a result of the work, six of the counties reached by the Educational Assistant, when revising their courses of study this year, included regular work in bird study; and it has been recommended or special mention made of it in ten of the other counties visited. Several other counties have also expressed a willingness to include work along this line when they revise their courses of study.

It has been the plan to make the talks before teachers' institutes as practical as possible, a part of the work dealing with methods of teaching the subject of bird study in the schools, this being followed by a lecture on the habits and value of a few common birds, the talk being illustrated with bird skins or colored slides. While meeting the teachers at institutes helps to arouse their interest, if bird study is to be really taken up in the schools, more material is required than can be given in the limited time afforded at a teachers' institute. Unless teachers have already had special training in this subject, they often hesitate to take it up, because the majority of them have very little time to look up extra material. In most cases, however, they are willing to make use of such material when it is sent to them. Therefore, it became evident that, if the teachers could be furnished with the needed data, they would be much more likely to take up the bird work. In order to meet this need, a 48-page manual on "Bird Study in the Schools" was compiled by the Educational Assistant, and issued by the Commission, as a bulletin, in March, 1912. This covers work on the following subjects: "How to Study Birds," "How to Teach Bird Study in the Schools," "How to Attract Birds," "Bird Laws," "Economic Value of Birds," "A Guide to the Study of a Few Birds," with a special section on "Some Common Game Birds," "Suggestive Questions for Children," and "Some Material Helpful in Bird Study." In connection with the bulletin a suggestive course of study on birds was also prepared, outlining briefly certain lines of work for each grade, from first to eighth inclusive. Both the bulletin and the course of study have been given free to all teachers who have expressed an interest in the work. Besides this, they have also been sent in response to requests received from libraries and various other institutions both in California and other states.

While the starting of a work may be important, no definite results can be obtained, and the interest is soon lost, unless it be carefully followed up. This will be done during the coming year through the medium of the "Teachers' Bulletin," a four-page leaflet, which will be sent, each month of the school year, to teachers taking up the bird study. It is believed that this will greatly increase the effectiveness of the work, by giving to the teachers, more in detail than was possible before, the work outlined in the above mentioned course of study. It is the aim to have each bulletin furnish enough material for one or more lessons. In this way it is hoped to systematize the work and keep in more definite touch with it.

An occasional bulletin will also be issued for the children, in order to aid in keeping up their interest, and in this will be published articles written by the boys and girls. As it will be the purpose of this bulletin to encourage original observations among the children, the articles printed will be chosen with reference to the knowledge which the child has gained from actual study of the live bird, not from books. From time to time certain special work will be outlined for the children to do by themselves, and on which they will be asked to report.

As in the wild life of California we have one of the State's most valuable assets, so the conservation of this wild life becomes a vital problem. But the question is, how can we place this work of conservation on a permanent basis. This must be brought about primarily through the education of the children in our public schools, for the protection of this wild life in the years to come must depend upon the boys and girls of to-day, our future lawmakers. One of our noted statesmen has said, "The preservation of the useful and beautiful animal animal and bird life of the country depends largely upon creating in the young an interest in the life of the woods and the fields."

What we need is an educational campaign as well as a legislative one, for laws are most effective only when supported by public sentiment. Nowhere is this work of more vital importance than in the public schools. Children should realize that the wild life is the property of the State and Nation and not of any one individual, and that as such we should protect it as we would any other state or national property.

In the talks on birds in the schools it has been the aim both to interest and instruct the children concerning the habits and value of bird life. While the sentimental phase of this subject may appeal to the girls, the boys, on the other hand, demand some practical reason for bird protection, and it is very important that this reason be given them. With this idea in view, it has been the economic side of the question which has been most strongly emphasized by the Educational Assistant in her talks before schools. The hearty response received has given ample proof that the surest means of getting our boys to protect the useful wild life of the State is to first convince them of the actual practical relation which it bears to their everyday lives. To be most effective, however, the economic status of this wild life should be considered not merely in its relation to one town, county, or even state, but with reference to its value in the country at large.

One result of the work with the children is shown in the fact that as their knowledge of the birds increases their attitude toward them changes. Believing that this result can be brought about most satisfactorily through actual observation of the live birds, the children are encouraged to study the birds in their native haunts, and in this way become familiar with their habits and value to man; for one discovery made by the boy himself is worth any number of facts gleaned from books or told him by the teacher. Certain methods are also suggested by which they can attract the birds about their homes and schools. Nesting boxes and food tables have been put out by boys and girls in different sections of California, and they have been encouraged to write to the Educational Assistant concerning results. Many interesting reports have been received from various localities in the State, and circular letters have been sent to the children in reply.

A systematic study of birds in the schools can be made of decided practical value, by teaching the children to recognize those birds which are useful and those which are harmful, with reasons for the classification. Following this they should be taught how to protect their bird friends and guard against the attacks of foes. Realizing the importance of having the children feel that they are doing some definite work, during the coming year it is planned to outline certain simple experiments in the protection of crops, which the children will be asked to try for themselves.

One great advantage of the work with the children is the fact that through them we are indirectly educating the men and women. Once get the children really interested and they will do more to convince their parents of the value of bird life than any amount of outside influence that could be brought to bear directly. The study of the economic value of birds has been defined as the study of birds from the standpoint of dollars and cents. This side of the question will appeal even to those parents who might consider any other phase of the subject as unprofitable and therefore a waste of time.

Over a billion dollars, that should go to the farmer, the gardener, and the fruit grower of the United States, are lost every year through the inroads of insects and rodents. As many of the boys in our public schools will be the agriculturists of the future, they should understand that in the birds we have one of nature's best checks to those pests which devastate the crops; and that the increase of the useful bird population of the State means an added agricultural prosperity.

While it is important that information should be given concerning the valuable non-game birds of our State, in the educational work of the Fish and Game Commission special emphasis should also be placed upon the question of game birds. With this idea in view, some characteristic game birds have been discussed by the Educational Assistant, both in the general public lectures and in the talks before schools. In this connection the question of certain game bird enemies has also been taken up.

It has been the aim of the Educational Assistant to carefully explain the game laws of the State, relating to birds, for every boy who is old enough to hunt should know these laws and should be able to distinguish clearly between legal and illegal game, with reasons for this distinction. It is believed that instruction along this line will help to do away with much of the promiscuous killing of wild life, and at the same time make of the boy not less of a hunter, but more of the right kind of a sportsman.

Realizing the importance of furnishing the teachers and children with information regarding the game birds, at least one issue of the Teachers' Bulletin will be devoted to this subject.

In traveling throughout the State the Educational Assistant has made a special point, whenever possible, of discussing game conditions with the people of the various sections. In this connection reports have come from certain of the mountain counties, regarding the destruction of mountain quail during the severe winters. As a case in point, the writer was told that in Plumas County during the winter following the two years closed season on the mountain quail, much of the increase thus brought about was destroyed on account of the heavy snow storms. This gave rise to the question whether a more general feeding of the quail during that particular season would not save many of these valuable game birds to the sportsmen. With this idea in view a plan is being outlined by the Educational Assistant, whereby it is hoped to interest the older boys in the grammar and high schools of the mountain counties, in the feeding of these birds during that portion of the winter when their natural food supply is cut off. The plan will be to also follow up this work with the idea of determining whether it may be made effective in lessening the destruction among these birds resulting from the hard winters.

With the increase in the number of hunters each year, and the corresponding decrease in certain of our best game birds, the question of game conservation becomes an important one. Therefore, the problem of educating our future sportsmen, the boys of to-day, becomes one of no little importance, for with them must rest in the years to come the protection of the game supply of our State.

INVESTIGATION OF THE ECONOMIC STATUS OF NON-GAME BIRDS.

By H. C. BRYANT,

Fellow in Applied Zoology on the Fish and Game Commission Foundation in the University of California.

With Figures 1–8.

LETTER OF TRANSMITTAL.

East Hall, University of California,
Berkeley, Cal., Sept. 16, 1912.

The Honorable Board of Fish and Game Commissioners for the State of California,

Gentlemen: I have the honor to submit herewith a report on the Bird investigations from the commencement of the work, January 1, 1911, to June 30, 1912.

The work of this department has consisted in the accumulation and publication of data regarding the relations of certain non-game birds to the agricultural interests of the State. Four methods have been used in the work—field investigation, experimentation, laboratory examination of stomachs, and circulars of inquiry.

Field investigation has been depended on to furnish data as to the depredations of birds, and as to the kind, quantity, and preference of food. Investigations of the relations of birds to insect outbreaks have been fruitful of valuable information as to the part played by birds in helping to maintain an equilibrium.

Experimentation has been relied upon to furnish evidence as to the kind, quantity, and the preference of food of nestlings, and the time of digestion.

Emphasis has been placed on the laboratory examination of stomachs, as this affords the most reliable information as to the food of birds.

Reports from the men most directly concerned are being depended on to furnish information as to the extent of the depredations of certain birds, and as to how they are regarded by those who are in a position to know their relations to agriculture.

It seemed best to concentrate effort on those birds of whose depredations most complaint has arisen in recent years. Endeavor has therefore been centered on the western meadowlark (*Sturnella neglecta*), the blackbirds (*Agelaius phœniceus subsp.*), (*Agelaius bicolor*), (*Euphagus cyanocephalus*), the western robin (*Plantesticus migratorius propinquus*), the horned lark (*Otocoris alpestris* subsp.), the western mourning dove (*Zenaidura macroura marginella*), and the roadrunner (*Geococcyx californicus*). Collections of these birds taken every month of the year, and in over twenty-five different localities in the State, have been made by the deputies of the Commission, and are now on hand in process of examination. Over eight hundred and thirty stomachs of meadowlarks have been examined in the laboratory, and their contents analyzed and tabulated. A final report on the economic status of this bird is in the course of preparation.

There is little positive information available regarding the abundance, distribution, migration, and food-habits of the game birds of the State. This information is necessary to a sane conservation policy.

It is the desire of this department to extend its work to include the game birds, and so be able to furnish this information.

It is hoped that this department, by furnishing positive data as to the food of certain non-game birds, and as to the life histories of the game birds of the State, may correct the widespread ignorance on these subjects, and may thus promote needed interest and protection, the principal factors in a sane conservation policy.

Respectfully submitted.

H. C. BRYANT,
In Charge Bird Investigations.

HISTORY OF THE INVESTIGATION.

The total extinction of the passenger pigeon and the near extinction of several other birds is bringing to the American people convincing evidence of the necessity of a thorough knowledge of the economic value of birds. The large number of publications on the food habits of birds issued by the U. S. Biological Survey and the State Agricultural Experiment Stations also confirms the view that this work is of great importance. California, with her well developed fruit and grain industries and her abundant supply of bird and animal life, must necessarily become more and more interested in the conservation of those birds and animals known to be beneficial, and in the extermination of those known to be harmful.

It is a well known fact that certain birds continually give trouble by destroying crops. Some of these same birds do an incalculable amount of good by destroying certain pests such as mice and insects which are injurious to vegetation. Still others because they have both good and bad habits do not belong to either class. Opinion as to the real value of certain birds varies greatly. This is often due to the fact that but little is known of their real food habits.

Continued complaints from the farmers and fruit growers of the State have been made to the California Fish and Game Commission regarding the losses to crops caused by the depredations of certain birds. The Commission has been urged repeatedly to take strong measures to avert the damage done. The usual measure urged is that the particular bird in question should be placed on the unprotected list. On the other hand, many scientists and others interested in birds, have pointed out the fact that birds not only confer a great benefit in keeping down the number of injurious insects and weed seeds, but also that they fill a niche in that balance of nature most suited to mankind which cannot be and is not filled by any other form of life. Man profits greatly by the services of birds, but not appreciating it, he returns evil for good. Experience has shown that many of those complaining of the depredations of birds have based their complaints on circumstantial evidence, or on evidence not sufficiently reasoned out. Furthermore, these complaints have brought out the fact that really very little is known of the food habits of birds throughout the whole year. Certain it is that a complete knowledge of the food habits of a bird is necessary to a determination of its economic status. As a result, therefore, the California Fish and Game Commission has felt that legislation should be based on comprehensive scientific investigations as to the value of birds, and not on circumstantial evidence. Consequently, an investigation into the relations of the birds of the State to agricultural and other interests was instituted.

In order that the investigation be both scientific and practical, it was determined to obtain precise knowledge of the food of birds by field work, supplemented by stomach examinations of birds taken in many different parts of the State each month in the year. Both of these lines of investigation are important as they each supplement the other.

A thorough knowledge of the nature and extent of the damage done by certain of our birds, combined with a full understanding of their value to the agriculturist as insect and weed-seed destroyers, such as is being made available by this investigation, will be of inestimable value to the rancher. For certain it is that the successful farmer of today and of the future will have to be able to estimate the status of the birds on his farm with reference to his own interests and to those of the community, and adopt measures accordingly.

Nor should the results of the investigation be interesting to the agriculturist alone. The United States Supreme Court has ruled that game and wild birds belong to the people and not to individuals. Information as to the value of this asset becomes important, therefore, just as information as to the value of forests is important. Consequently the present investigation deserves the interest and support of not alone those directly involved, but of all those interested in the conservation of a national resource.

Through the co-operation of the University of California, there have been afforded not only suitable laboratories for the work of stomach examination, but also the advice and help of Professor C. A. Kofoid of the Department of Zoology, Mr. Joseph Grinnell, Director of the Museum of Vertebrate Zoology, and Professor C. W. Woodworth of the Department of Entomology, as well as others connected with that institution.

THE INVESTIGATION AS TO METHOD.

FIELD INVESTIGATION.—A STUDY OF THE BIRD AT THE SCENE OF ACTION.

The attempt has been made to combine the best of the methods heretofore used by economic ornithologists, and to supplement these methods by new ones of value. We believe the following improved methods in determining the economic status of birds will tend to a nearer attainment of the end sought—a reliable estimation of the economic value of a bird.

1. Complete data as to the birds collected for stomach examination is furnishing information as to the variation in kind, amount, and preference of food of a bird, according to the hour, day, week, month, year, environment, and sex.
2. The use of a combination of methods of stomach examination is tending to decrease personal error, and is allowing a more accurate determination of the food habits.
3. The food capacity of different birds is being determined by a measurement of the volume of food in cubic centimeters.

4. Experimentation is affording data as to the amount, kind, and preference of food, and to the time of digestion.

5. Field investigation is furnishing evidence as to the depredations of birds, their general habits and abundance, and their value in maintaining a natural equilibrium of insect life.

6. Investigations which have been undertaken to determine the relation of birds to insect outbreaks are demonstrating the economic value of birds at such times.

7. A comparison of all the helpful qualities of a bird with all of its qualities injurious to the welfare of mankind is affording a dependable criterion of its economic status.

Next to the knowledge of the food of a bird in determining its economic status, is a knowledge of the habits of a bird. Its abundance, feeding habits, nesting habits, food preferences, its depredations, etc., are all factors that must be considered. Evidence along this line can be afforded only by field investigation.

The field work carried on thus far can be grouped under three heads: studies of the abundance, feeding habits, nesting habits, etc.; studies of the food of birds; and studies of the relation of birds to insect outbreaks.

STUDIES OF THE ABUNDANCE, FEEDING HABITS, NESTING HABITS, ETC., OF BIRDS.

A month's time has been spent at Lathrop, San Joaquin County, California, studying the abundance, feeding habits, nesting habits, depredations, etc., of birds, especial attention being given to the meadowlark and blackbird. This particular locality was chosen because it afforded not only an abundance of birds, but also a favorable proportion of cultivated and uncultivated land, thus allowing a study of food preference.

Censuses and studies of the rate of reproduction have been carried on to ascertain the relative abundance. Work in the spring of 1911 and 1912 substantiated the fact that meadowlarks, Brewer blackbirds, and red-winged blackbirds usually nest twice each year.

The average brood of the meadowlark is four, although the number of eggs laid is usually five. Second nestings examined have usually showed an incomplete set of eggs. A preference for pasture land for nesting sites was shown, at least 86 per cent of those found being so situated. The time of incubation was found to be fourteen to sixteen days. The young stay in the nest but a short time (eight to ten days). Nestlings are subject to many enemies, such as the skunk, weasel, mice, and hawks, and the number of broods successfully reared is less than that of most other birds. That over 15 per cent of the nests in most localities are destroyed by predaceous animals and birds seems a very conservative estimate.

These facts have an important bearing on the economic relations of the meadowlark. Their particular habitat influences the amount of damage done, due to the locality in which they are found. Their rate of reproduction influences the amount of damage due to the number of individuals to be expected in any locality.

STUDIES OF THE FOOD OF BIRDS.

No small part of the field work has consisted in investigations of the damage caused by birds. In most cases the field work has been supplemented by stomach examinations.

Investigations of the damage caused by meadowlarks has led to the following conclusions:

1. The western meadowlark (*Sturnella neglecta*) is destructive in sprouting grainfields, because of its habit of drilling down beside the sprout and pulling up the kernel. The amount of damage done is dependent on the particular location, the abundance of the birds, the character of the soil, and the kind of grain. The damage to oats is greatest; wheat suffers considerable damage, whereas barley suffers but little. Broadcasted grain suffers more than drilled, because not being sowed so deeply, it is more easily obtained by meadowlarks. The birds often follow the drill row, however, and pull almost every kernel (Fig. 1). Occasionally, where meadowlarks are very numerous and the quantity of grain small, fields have had to be resown. The real amount of damage done has evidently been overestimated, for fields apparently badly damaged have given the average yield later in the year. After the second and third leaf appears on the grain, the bird can do little damage. This fact reduces the duration of their depredations to less than two weeks, and consequently minimizes the amount of destruction possible.

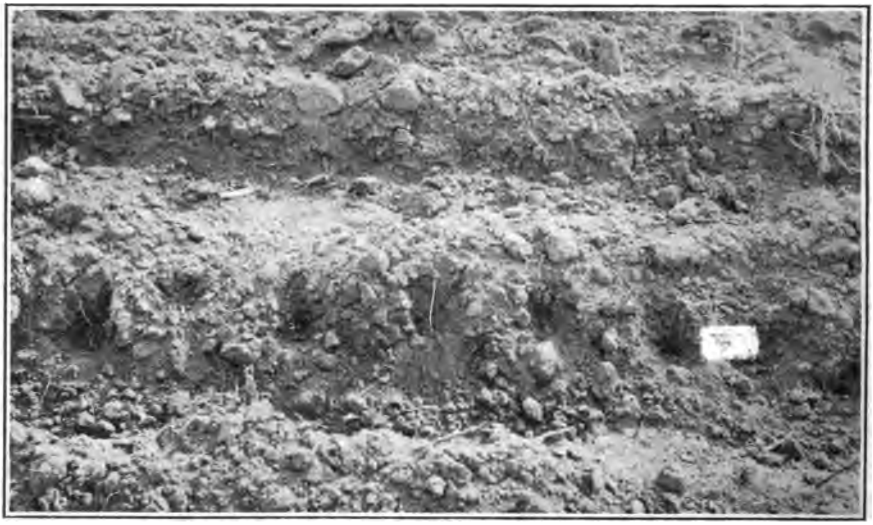


FIG. 1.—Holes drilled by western meadowlarks in pulling sprouting grain. Photograph taken by H. C. Bryant, at Lathrop, San Joaquin County, California, February 28, 1912.

2. Investigation of complaints that meadowlarks are destructive to melons has shown that damage caused in this way has been exaggerated. Melon growers, although admitting that the birds cause considerable damage, have often been unable to demonstrate the actual damage in the field. Of two melon growers in the vicinity of Dinuba, whose names were handed in as men who were greatly troubled, one returned a verdict of "not guilty" and the other admitted that the damage was not very great. All of the growers report that as soon as there are broken melons in the field the birds cease to be troublesome. From the evidence obtainable, it appears that the meadowlark drills into melons to obtain water. The placing of water in a field as an experiment would doubtless confirm or abrogate this view. Such an experiment is contemplated.

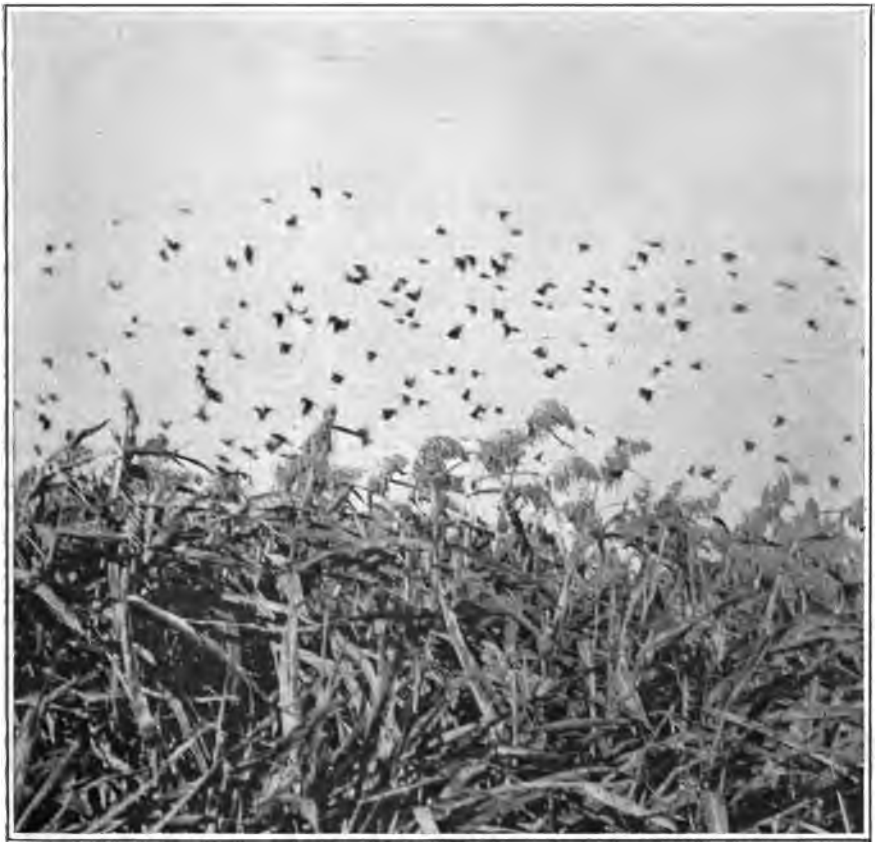


Fig. 2.—Red-winged blackbirds feeding on kafir corn. Photograph taken by H. C. Bryant, at Lathrop, San Joaquin County, California, October 3, 1912.

3. Censuses have demonstrated that the western meadowlark prefers grass land to cultivated land, nearly 50 per cent more birds being found on the first named.

Investigation of the damage caused by blackbirds has led to the following conclusions:

1. Red-winged blackbirds (*Agelaius phœniceus subsp.*) and (*Agelaius tricolor*), because of their greater abundance and their food habits are by far the most destructive of the blackbirds.
2. The percentage of insect food taken by Brewer blackbirds (*Euphagus cyanocephalus*) is much greater than that taken by redwings.
3. Red-winged blackbirds are destructive to barley when "in the milk." Ranches within ten miles of rivers or other breeding grounds are the most affected. The amount of destruction varies greatly with the abundance of the birds.
4. Red-winged blackbirds are destructive to Egyptian corn and kafir corn (Fig. 2). They appear to be especially fond of this sort of grain and will gather in flocks of thousands, often causing considerable damage, especially near rivers where the birds are abundant. Small fields of this sort of grain are often completely stripped by the birds. Milo maize suffers little damage if these other grains are available. Protection of fields by scarecrows or by shooting has proved unsuccessful.

An investigation of the damage to almonds caused by the Lewis woodpecker (*Asyndesmus lewisi*) showed that this bird was destructive to almonds in certain localities, in the spring of 1912. The almond growers of the Capay Valley apparently suffered the most, and probably with good reason, for in this particular valley the birds were especially abundant. Over 65 per cent of all the food eaten by the birds examined was made up of small pieces of almonds. The exceptionally dry year which caused a shortage in the usual food supply, was probably responsible for this unusual occurrence.

STUDIES OF THE RELATION OF BIRDS TO INSECT OUTBREAKS.

A study of these same birds at the time of an insect outbreak has shown them to be important in the restoration of that balance of nature most suited to mankind. In the investigation of an insect outbreak in northern California during the spring and summer of 1911, when the nymphalid butterfly (*Eugonia californica*) became abnormally abundant, it was found that the Brewer blackbird was the most efficient destroyer of the insects, both on account of its numbers and its food habits, taking 95 per cent of all the butterflies taken by birds. Examination of the stomachs of thirteen red-winged blackbirds (*Agelaius phœniceus* subsp.) showed that over 93 per cent of their food was of vegetable matter. The Brewer blackbirds (*Euphagus cyanocephalus*) examined, on the other hand, had taken 83 per cent of animal food, showing the vast difference in food habits. Meadowlarks were found to feed on the butterflies to a small extent, as was also the western kingbird (*Tyrannus verticalis*), the blue fronted jay (*Cyanocitta stelleri frontalis*), and the Say phœbe (*Sayornis sayus*).

EXPERIMENTATION.

EXPERIMENTS WITH CAPTIVE BIRDS.

Experiments to determine the kind and quantity of food, and the time of digestion have been carried on. Nestling birds, because they were most available, were used in the experiments. The birds were not allowed any food for a long enough time to insure an empty stomach. They were then fed a certain amount of food. After varying periods of time they were killed and the stomachs and intestines examined. The position and condition of the food (recognizable hard parts) in the stomach and intestines at intervals after feeding, afforded evidence as to the time of digestion. Evidence as to the food of nestlings has also been obtained. A daily weighing of the nestlings and their excreta has furnished evidence as to the quantity of food required.

The results can be summed up as follows:

1. Meadowlarks have a great capacity for food. A nestling was fed twenty-eight grasshoppers (one half inch in length) inside of fifteen minutes.
2. The time of digestion of grasshoppers and beetles is two to four hours. Cut worms are digested more quickly.
3. The time of digestion of grain (wheat) is three to six hours.
4. Nestlings are fed almost exclusively on insects—cutworms, beetles, and grasshoppers being the principal items.
5. Nestling meadowlarks consume about their own weight of food every day. They gain very nearly one fourth of an ounce in weight each day they are in the nest.

LABORATORY EXAMINATION OF STOMACHS.

COLLECTION OF NON-GAME BIRDS.

Collections of birds in sufficient numbers to furnish reliable data, collected every two weeks during the year, and from over twenty-five different localities in the State, have been made available through the co-operation of the deputies of the Commission. Each bird has been tagged with data as to date, time of day, locality, kind of field or orchard, and name of collector. They have then been preserved in formalin solution and shipped to the University. On the arrival of shipments at the laboratory the stomach has been removed and data as to the species and sex of the different birds added. The tag bearing complete data has then been wrapped with the stomach in a small cloth and preserved in formalin solution until microscopically examined. Although the collection of non-game birds by the deputies for the investigation has often been interfered with by the absence of the deputy on important work, or by the replacing of deputies, yet series of birds taken each month of the year in sufficient numbers to furnish reliable evidence as to their food are at hand from many different localities in the State. So far as possible all incomplete series will be completed this coming year.

In order that the work in 1911 might be verified, collections have been continued in several places during 1912. This will afford a comparison of the food in two succeeding years.

The accompanying map (Fig. 3.) shows the localities in which collections have been made. The localities from which complete series were made and those localities from which incomplete series have been obtained are indicated.

A correct determination of the economic status of a bird is largely dependent on a knowledge of its food. The food of a bird can be roughly determined by watching the bird in the field. The most dependable data concerning the food of most birds, however, is obtained by examining the contents of the bird's stomach. Consequently stomach examination has been largely depended upon to furnish needed evidence as to the food of the birds under investigation.

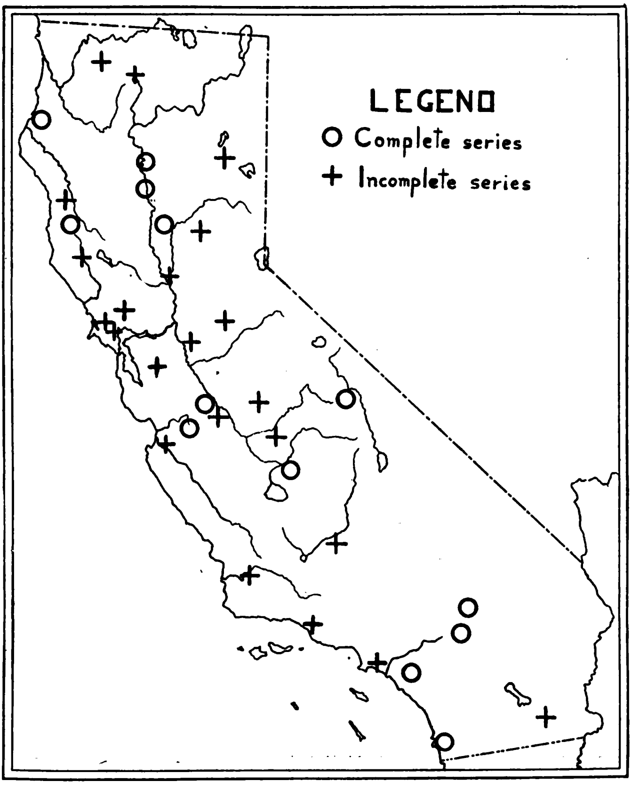


FIG. 3.—Map of California showing localities from which non-game birds have been collected for stomach examination.

EXAMINATION OF STOMACH CONTENTS.

In the examination of the stomach contents a Zeiss binocular has been used. After the contents has been carefully removed from the stomach and placed on a glass plate, the binocular is used in sorting, counting, and identifying the different kinds of food. A determination of the number of insects, seeds, etc., is made by counts. The number of grasshoppers and crickets eaten is determined by a count of the paired mandibles found. The undigested skins furnish evidence as to the number of cutworms; and the number of heads found determines the number of beetles and bugs. The data both as to the bird and the stomach contents is then recorded on a stomach blank. The stomach contents has been preserved in small vials in every case, so that a verification of the work is possible at all times. Final data is recorded on large blanks, which, when bound together, will give a complete record of each stomach examined.

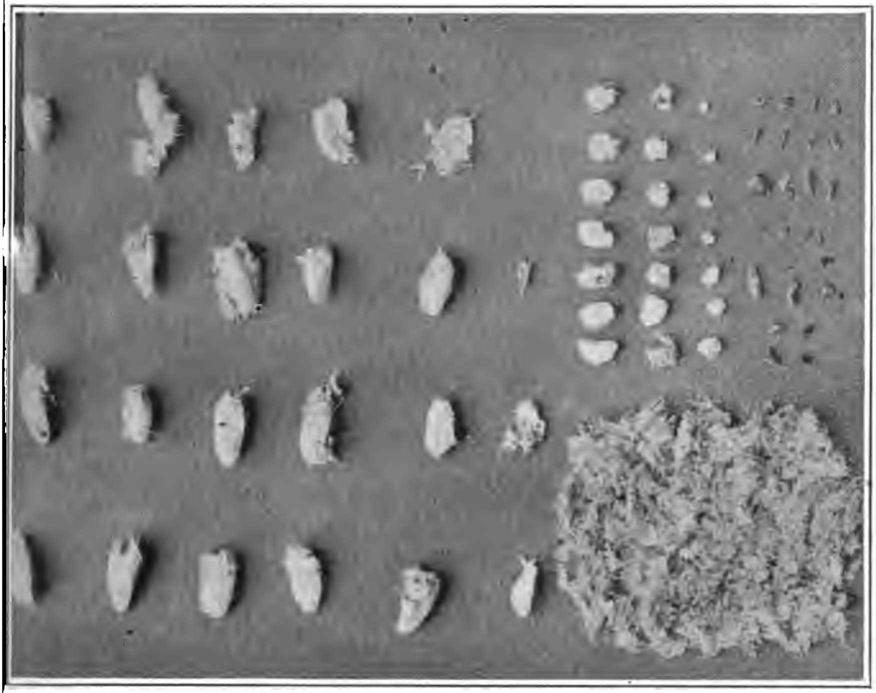


FIG. 4.—Photograph of the stomach contents of a western meadowlark, taken in a grainfield at El Toro, Orange County, California, May 5, 1911. The stomach contained 19 oat kernels, oat hulls, and parts of two small beetles. (Original.)

The following is a summary of the stomachs microscopically examined in the laboratory, from January 1, 1911, to June 30, 1912:

Bird Stomachs Microscopically Examined January 1, 1911, to June 30, 1912.

Western meadowlarks	Red-winged blackbirds	Brewer blackbirds	Western robins	Horned larks	Western mourning doves	Roadrunners	Woodpeckers	Western kingbirds	Orioles	Shrikes	Miscellaneous	Total
831	63	9	46	2	9	1	15	2	6	2	25	1,011

IDENTIFICATION OF STOMACH CONTENTS.

The different insects, seeds, etc., found in a bird's stomach are often so finely comminuted that they are difficult to identify. Much of the material, however, it has been possible to determine as far as the family, and in many instances to the genus and species. The food contained in a bird's stomach can usually easily be separated into two classes—animal food and vegetable food. The animal food consists largely of insects, and the vegetable food of grain and weed seeds (Fig. 4). Reference collections of insects and weed seeds have afforded material for comparison. Identification by government experts has often been resorted to.

SOME FACTS BROUGHT OUT BY THE STOMACH EXAMINATION.

Among the insects found in the stomachs of western meadowlarks, the following are the most common:

Orthoptera.

Cricket	*Gryllus pennsylvanicus.*
Jerusalem cricket	*Stenopelmatus californicus.*
Grasshopper	*Dissosteira spurcata.*
Valley grasshopper	*Oedaleonotus enigma.*
Differential grasshopper	*Melanoplus differentialis.*
Grasshopper	*Shistocerca* sp.

Hemiptera.

Squash-bug	*Anasa* sp.
Stink-bug	*Podisus* sp.
Stink-bug	*Pentatoma* sp.
Leafhopper	*Stictocephala franciscana.*
Negro-bug	*Corimelæna anthracina.*

Diptera.

Cicada	*Platypedia* sp.
Flower-fly	*Eristelis tenax.*
Flower-fly	*Syrphus.*
Ground-beetle	*Pterosticus* sp.
Ground-beetle	*Anisodactylus dilatus.*
Pinicate bug	*Eleodes* sp.
Carrion-beetle	*Silpha* sp.
Rove-beetle	*Staphylinus* sp.
Click-beetle	*Drasterius* sp.
	Limonius californicus.
	Limonius canis.
Devil-beetle	*Phloedes diabolicus.*
	Platynus ovipennis.
	Coniontis subpubescens.
	Calathus ruficolus.
	Blapstinus sp.
California flower-beetle	*Diabrotica soror.*
Leaf-beetle	*Disonycha* sp.
	Cardiophorus tenebrosus.
	Saprinus fimbriatus.
Grain weevil	*Sphenophorus* sp.

Hymenoptera.

Cuckoo-fly	*Chrysis* sp.
Bumblebee	*Bombus californicus.*
Carpenter ant	*Camponotus* sp.
Harvester ant	*Messor andrei.*
California agricultural ant	*Pogonomyrne californicus.*
Wasp	*Vespa* sp.
Cow-killer	*Sphærophthalma californica.*

Beetles are taken each month of the year. Cutworms form a large percentage of the food during the spring, whereas grasshoppers and crickets form the largest part of the food during the summer and fall months (Fig. 5, Fig. 6). Certain plant bugs, wild bees, wasps, ichneumon flies, and ants are also taken to a less extent. Spiders, scorpions, ant lions (*Myrmeleon* sp.), centipedes (*Scoleopendra* sp.), thousand-legged worms (*Tulus* sp.), and sowbugs have also been found.

Grain has been been found in considerable quantity in the stomachs of meadowlarks. Oats appears to be preferred, although wheat is often found. The wild variety of oats (*Avena fatua*) far exceeds in amount the cultivated varieties. Very little of that found in the stomachs is sprouted. Field investigation showed that sprouted grain is often crushed in the bill to get the milk, and then dropped on the ground.

Seeds of the following common weeds have been taken from the stomachs of western meadowlarks:

Sorghum	*Andropogon sorghum.*
Canary-grass	*Phalaris* sp.
Darnel	*Lolium temulentum.*
Amaranth	*Amaranthus* sp.
Buttercup	*Ranunculus* sp.
Knotweed	*Polygonum* sp.
Mustard	*Brassica* sp.
Bur-clover	*Medicago denticulata.*
Clover	*Trifolium* sp.
Sweet clover	*Melilotus* sp.
Alfalfa	*Medicago arabica.*
Dock	*Rumex crispus.*
Alfilaria	*Erodium cicutarium.*
Turkey weed	*Eremocarpus setigerus.*
Amsinckia	*Amsinckia intermedia.*
Nightshade	*Solanum* sp.
Bedstraw	*Galium* sp.
Tarweed	*Hemizonia* sp.
Star-thistle	*Centaurea melitensis.*
Zea	*Zea mays.*

The relative proportions of animal and vegetable matter taken by western meadowlarks in California has been fairly well demonstrated by the stomach examinations. The average amounts of the different kinds of food consumed by 650 meadowlarks taken at six different localities in the State (Red Bluff, Tehama County; Live Oak, Yolo County; Newman, Stanislaus County; Hanford, Kings County; Big Pine, Inyo County, and San Diego, San Diego County), when platted in the form of a curve, show the following results (Fig. 8). The minimum amount of animal food (4.15 per cent) is taken in January, and the maximum 93.83 per cent) in July. During the spring months there is a sudden increase in the amount of animal food taken, whereas a sudden decrease is to be noted in the fall months. The percentage closely parallels the availability of insect food. The maximum amount of cutworms is taken in May and June; the maximum number of grasshoppers in July and August. Grain as an element of food reaches a maximum in January and a minimum during July. The maximum consumption of weed seeds is in October.

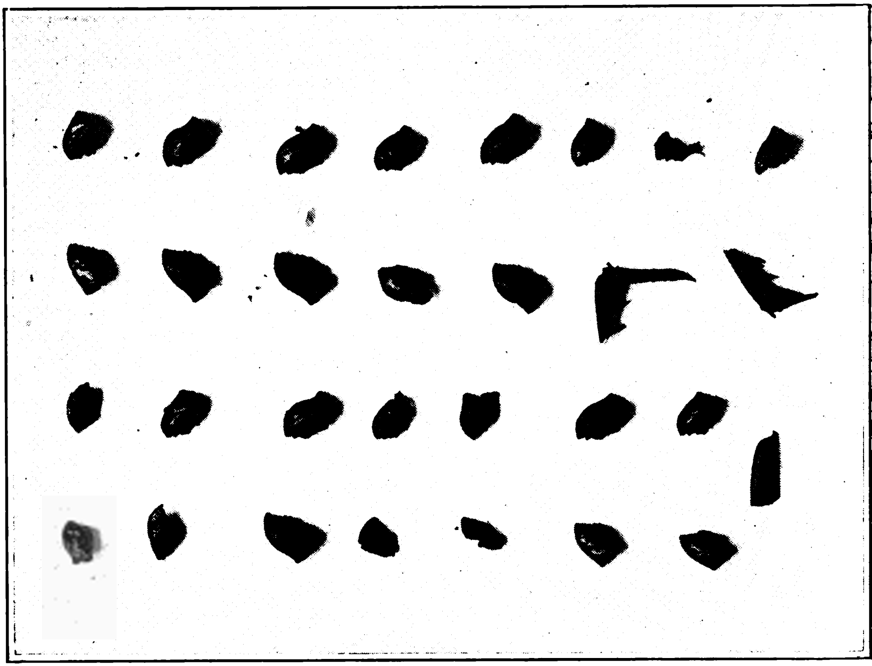


FIG. 5.—Photograph of twelve pair of mandibles of the common cricket (*Gryllus* sp.) taken from the stomach of a western meadowlark collected in a grain field at El Toro, Orange County, California, April 18, 1911. (Original.)

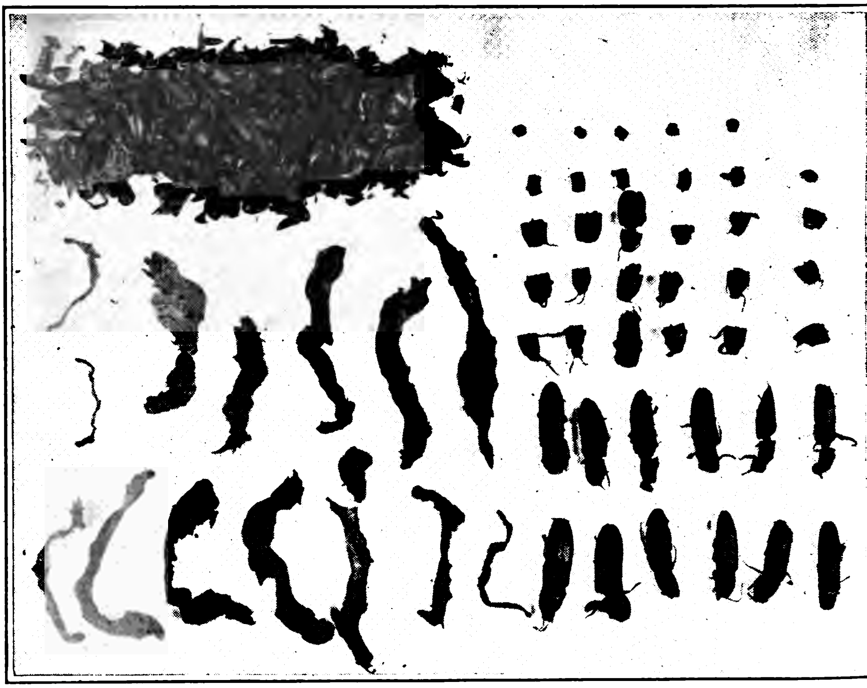


FIG. 6.—Photograph of stomach contents of a western meadowlark collected at Big Pine, Inyo County, California, April 19, 1911. The stomach contained 13 cutworms, 26 elaterid beetles (*Drasterius* sp.), and ten small ground beetles. (Original.)

FIG. 7.—Photograph of stomach contents of a western meadowlark taken in a barley field at El Toro, Orange County, California, May 3, 1911. The stomach contained 2 cutworms, 44 ground beetles (*Calathus ruficollis*), 2 flies, 1 spider, and 13 fly pupæ (*Syrphus.*). (Original.)

The total food for the year consists of 58.6 per cent of animal matter and 41.4 per cent of vegetable matter. This result differs considerably from that of Beale (Birds of California, U. S. Dept. Agric., Div. Biol. Surv., Bull. 34, 1910, p. 66). In the examination of 91 meadowlarks collected in California Dr. Beale found 70 per cent of animal and 30 per cent of vegetable matter. The difference may be due to the fact that most of the birds examined by the writer were evenly distributed through the year and were collected in localities where grain was obtainable. This larger percentage of vegetable matter does not necessarily minimize the value of the bird, for a large part (30 per cent) is made up of weed seed. It seems reasonable to believe that the examination of a larger number of stomachs of meadowlarks will not appreciably change these results. It can be expected, however, that additional data will smooth out the accompanying curve.

Stomach examination of red-winged blackbirds has demonstrated the fact that they feed to a considerable extent on vegetable matter, weed seed being the principal element. Cutworms and grasshoppers form a large percentage of the food when they are available.

Brewer blackbirds take a larger percentage of animal food than do the red-wings. They appear to be especially beneficial in the destruction of cutworms, wireworms, and grasshoppers.

Too few stomachs have been examined to give any adequate idea of the food-habits of the western robin. The material found in the stomachs examined has been composed largely of wild fruit and cutworms. One hundred and ninety-two small cutworms were found in one of the stomachs.

Stomach examinations of the mourning dove has shown the bird to be very valuable as a destroyer of weed seeds. Its great capacity (several thousand seeds having been found in a single stomach) and its fondness for the seeds of such weed pests as the mustard, turkey mullein, and tumble weed attest its value. A very strong sentiment in favor of placing this bird on the protected list is rapidly being developed in this State. Further work will certainly but demonstrate anew the value of this bird to agricultural interests.

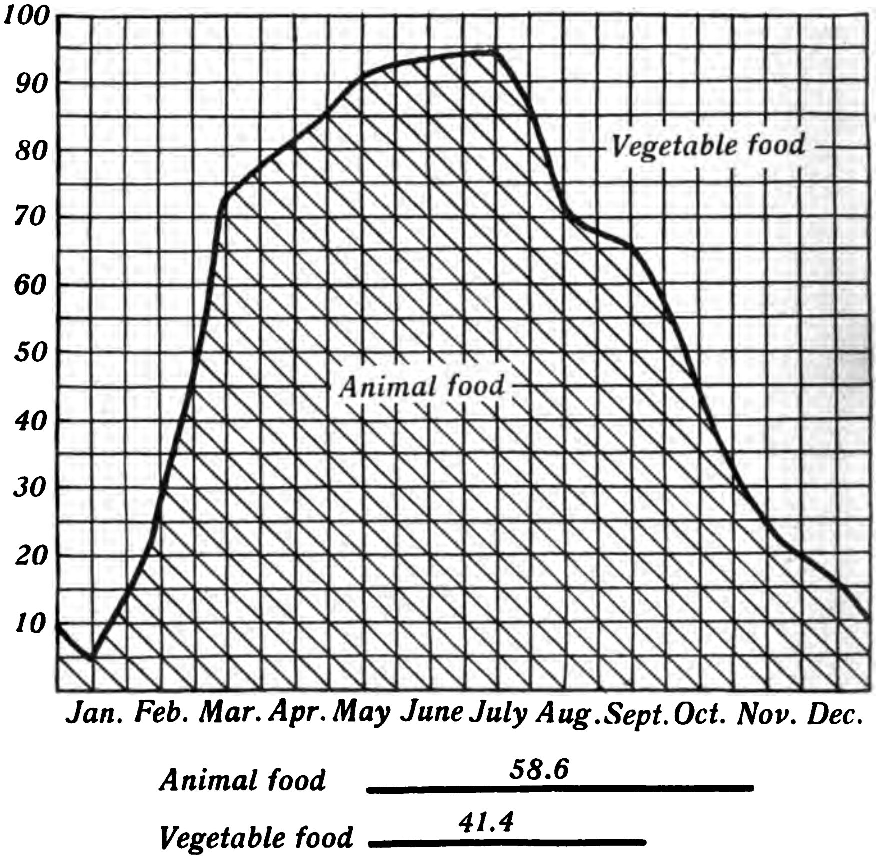


FIG. 8.—Diagram showing the proportion of animal and vegetable food of the western meadowlark (*Sturnella neglecta*) for the year.

Judging from the examination of one stomach, the investigation of the food-habits of the roadrunner will reveal some astonishing facts as to its capacity and food. The following was found in the stomach:

12 grasshoppers.
1 cicada fly (*Platypedia* sp.)
2 noctuid moths.
1 ant lion (*Myrmeleon* sp.)
2 robber flies.
2 beetles.
6 bumble bees.
4 spiders.
1 harvest mouse (*Reithrodontomys longicauda*).
1 egg mass.

VIEWS OF THE MEN CONCERNED.

In order that the men most directly concerned might furnish evidence as to the economic value of the meadowlark, a list of questions has been sent out to ranchers throughout the State. The response to these circular letters has not been as great as was hoped it might be. More of the blanks will be distributed this coming year, so that a fairer idea of the opinion of ranchers may be obtained. The questions, with a summary of the answers received, follow:

Dear Sir: The State Fish and Game Commission has taken up the study of the meadowlark in its relation to agriculture and desires to know what you think of the bird. In order to secure comprehensive and uniform data answers to the following questions are urgently requested:

1. Name---------------------------. 2. Address---------------------------
3. Occupation ---
4. How many acres of land do you own?----------. Is your ranch hilly, upland or bottom land?--------------------------.
5. What is the principal crop raised?------------------------------------. What other crops? ---
6. Has the meadowlark done any harm on your place?------------------------- If so, how and to what extent?-- ---
7. Have you examined the stomachs of any meadowlarks to ascertain their food? ----------------------------. If so, what was in the stomach?------------ ---
8. Approximately, how many meadowlarks are seen daily on your place?---------- Are the numbers any greater when the grain is sprouting?--------------------
9. Do you prize the meadowlark as a song bird?------------------------------
10. On the whole do you consider the meadowlark a nuisance?-------------------

When the returns as to whether the meadowlark is a nuisance, and as to whether it causes damage to crops are classified as to counties, the results are as follows:

Locality.	Number reporting.	Is the meadowlark a nuisance?		Does the meadowlark damage crops?	
		Yes.	No.	Yes.	No.
Coast counties	13	3	9	4	9
Central valley counties	39	20	13	24	15
Northern California	76	28	41	33	43
Southern California	12	1	10	2	10

The results show that a majority of those who have taken the trouble to answer the circular letter do not consider the meadowlark a nuisance. When the answers are classified as to counties, it becomes evident that the bird does practically no harm in Southern California. The greatest amount of complaint comes from the San Joaquin Valley. This can be easily explained. Grain is the usual crop raised in this locality, and meadowlarks are more abundant here than elsewhere. The combination of these two factors explains the reason for this greater complaint. These reports have substantiated the conclusions reached in field work—damage to sprouting oats is greatest; damage to melons has been exaggerated.